What will happen during YOPP SOP3?

Gunilla Svensson

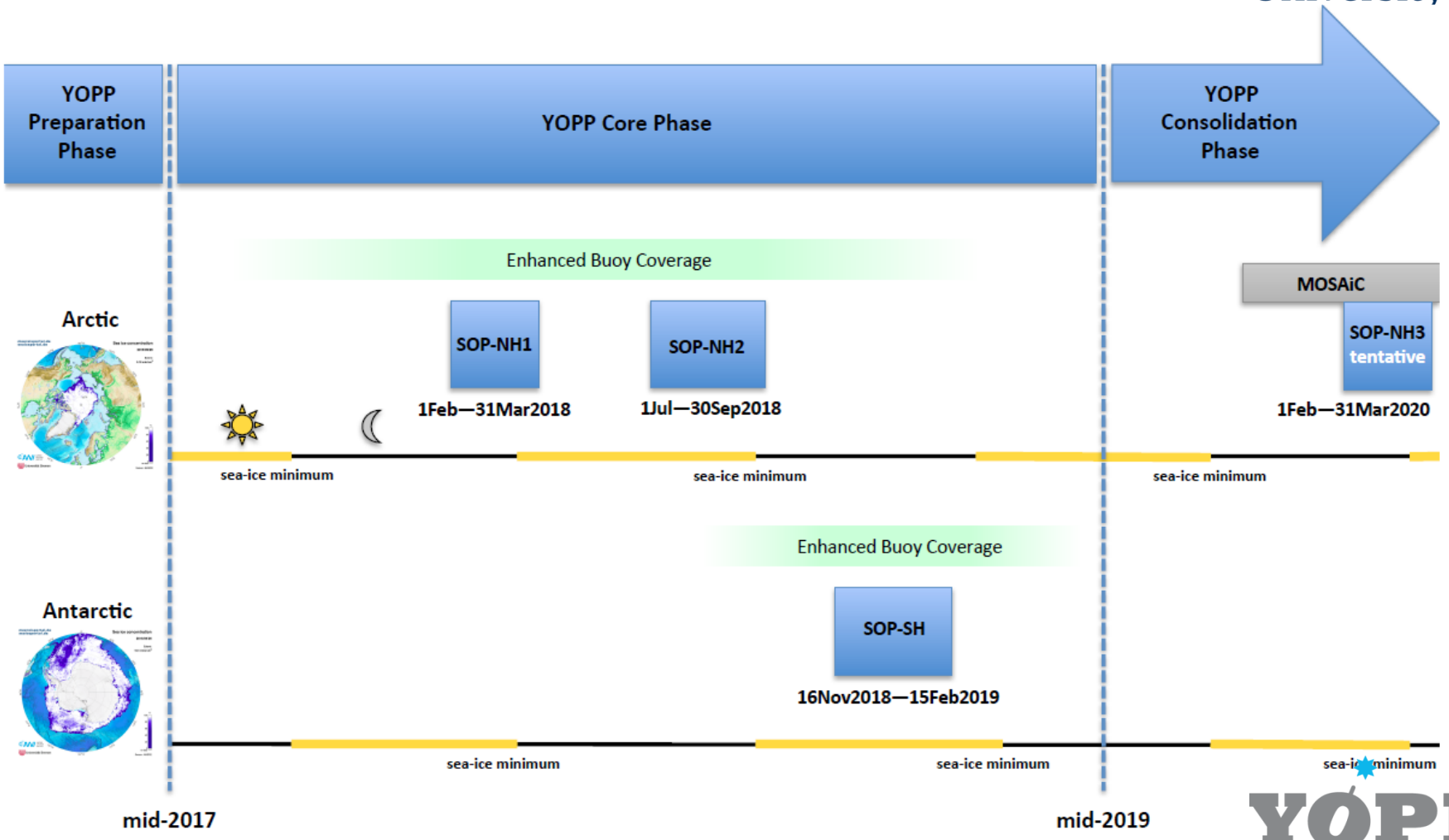
**Department of Meteorology,
Bolin Centre for Climate Research and
Swedish e-science Research Centre (SeRC)**

Barbara Casati, ECCC; James Doyle, NRL; Jun Inoue, National Institute of Polar Research; Steffen M. Olsen, DMI; Felix Pithan, AWI; Ian Renfrew, University of East Anglia, Thomas Spengler, Bergen University; Taneil Uttal, NOAA; Timo Vihma, FMI; Manfred Wendisch, Leipzig University and Matt Shupe, University of Colorado/NOAA

Observational campaigns for better weather forecasts, ECMWF, 10-13 June, 2019

Year Of Polar Prediction

Stockholm University



YOPP YEAR OF POLAR PREDICTION

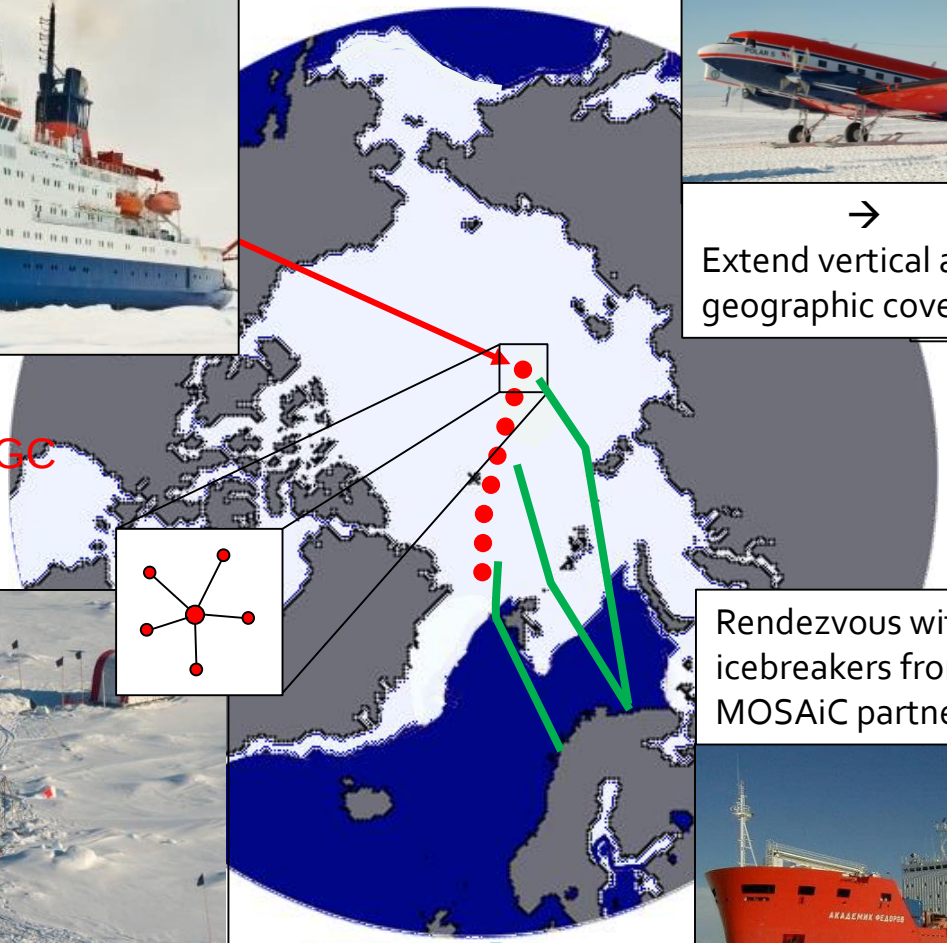
A Year in the Arctic

September 2019 – October 2020

Stockholm University

Coupled observations
Atmos-Ice-Ocean-Eco-BGC

→ Extend vertical and geographic coverage



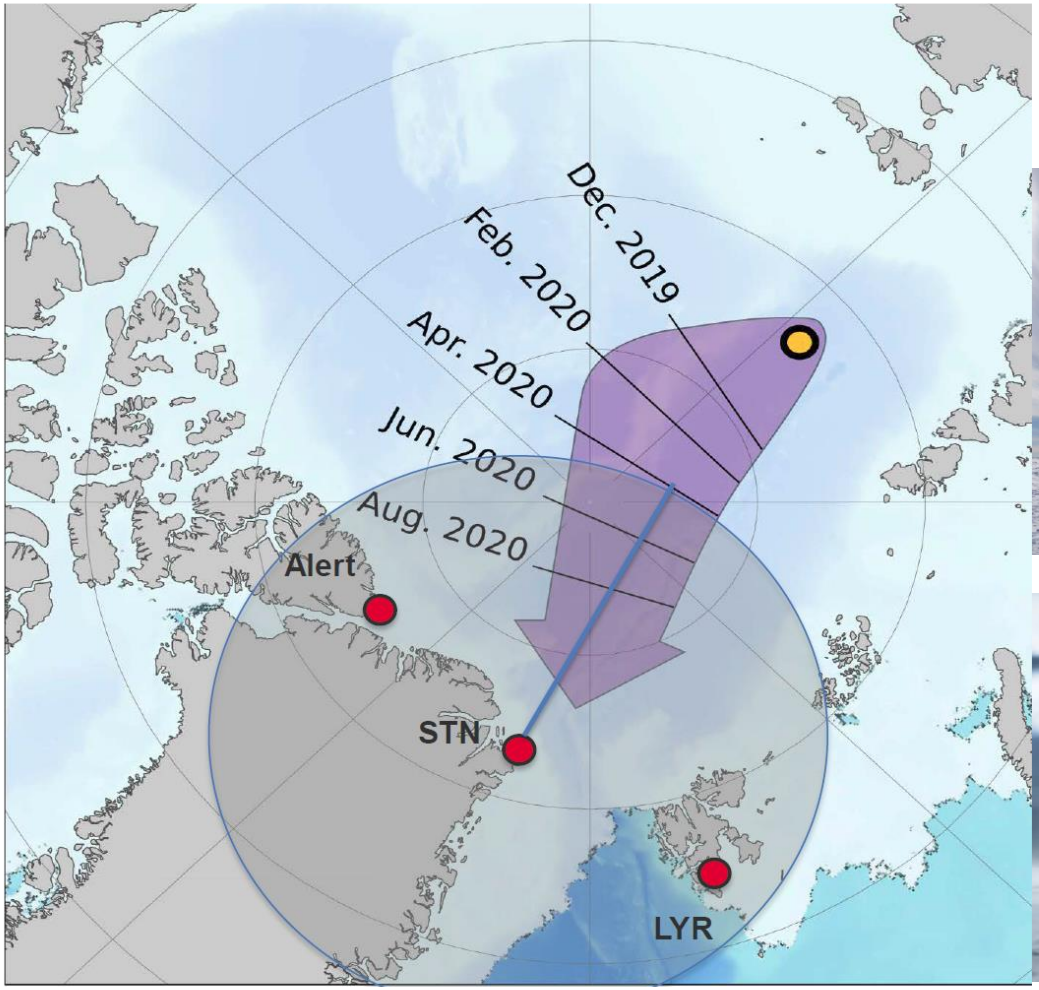
Autonomous systems, buoys,UAS, AUV

→ Broader geographic coverage & supply

MOSAiC
International Arctic Drift Expedition

MOSAiC

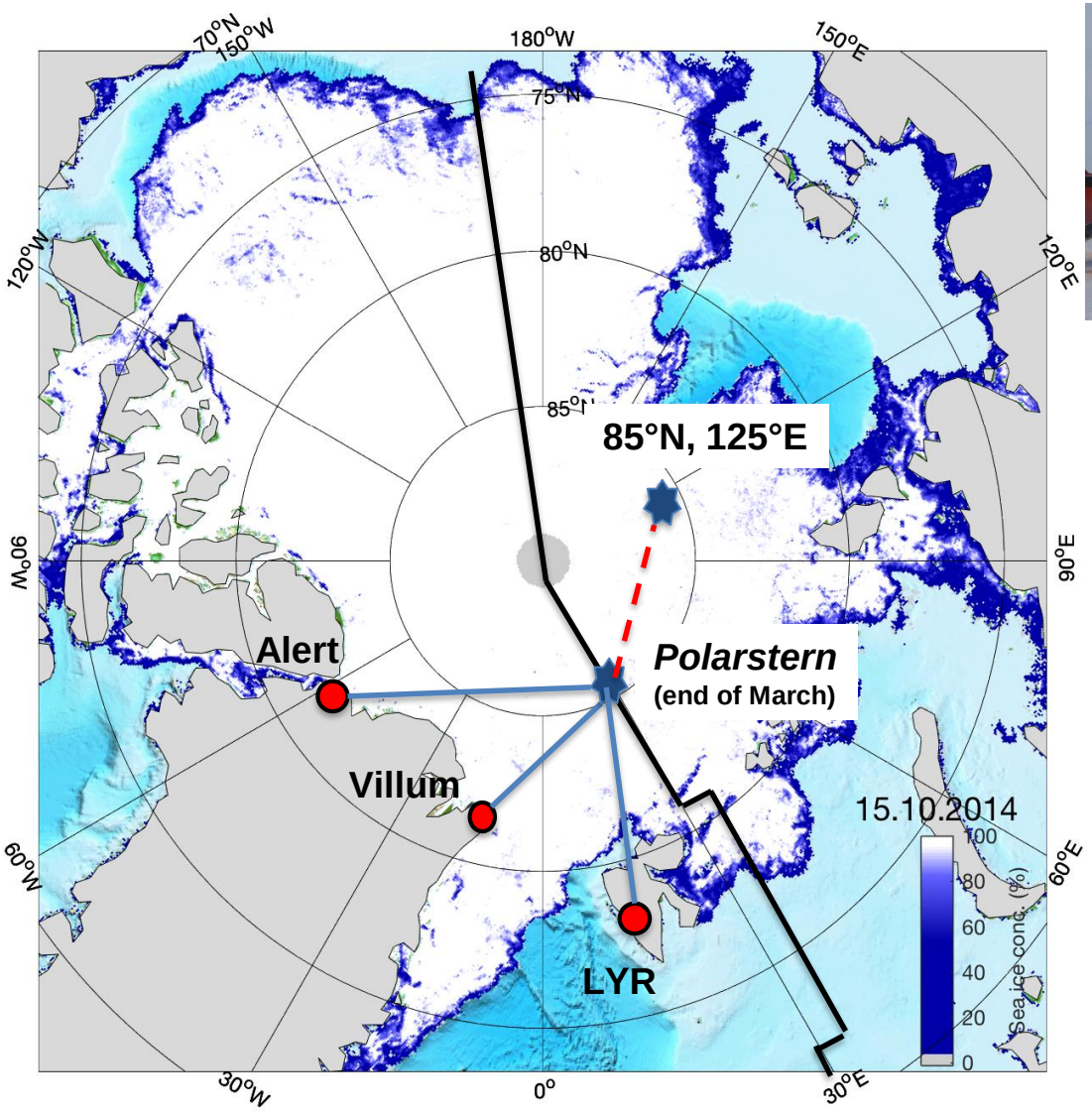
Stockholm University



MOSAiC
International Arctic Drift Expedition

www.mosaic-expedition.org

AWI AIRCRAFT OPERATION



Atmosphere (Polar 5 & 6)

SPRING (160 h)

16 March – 07 April 2020

SUMMER (100 h)

28 August – 15 September 2020

Sea Ice & Snow (Polar 5)

SPRING (80 h)

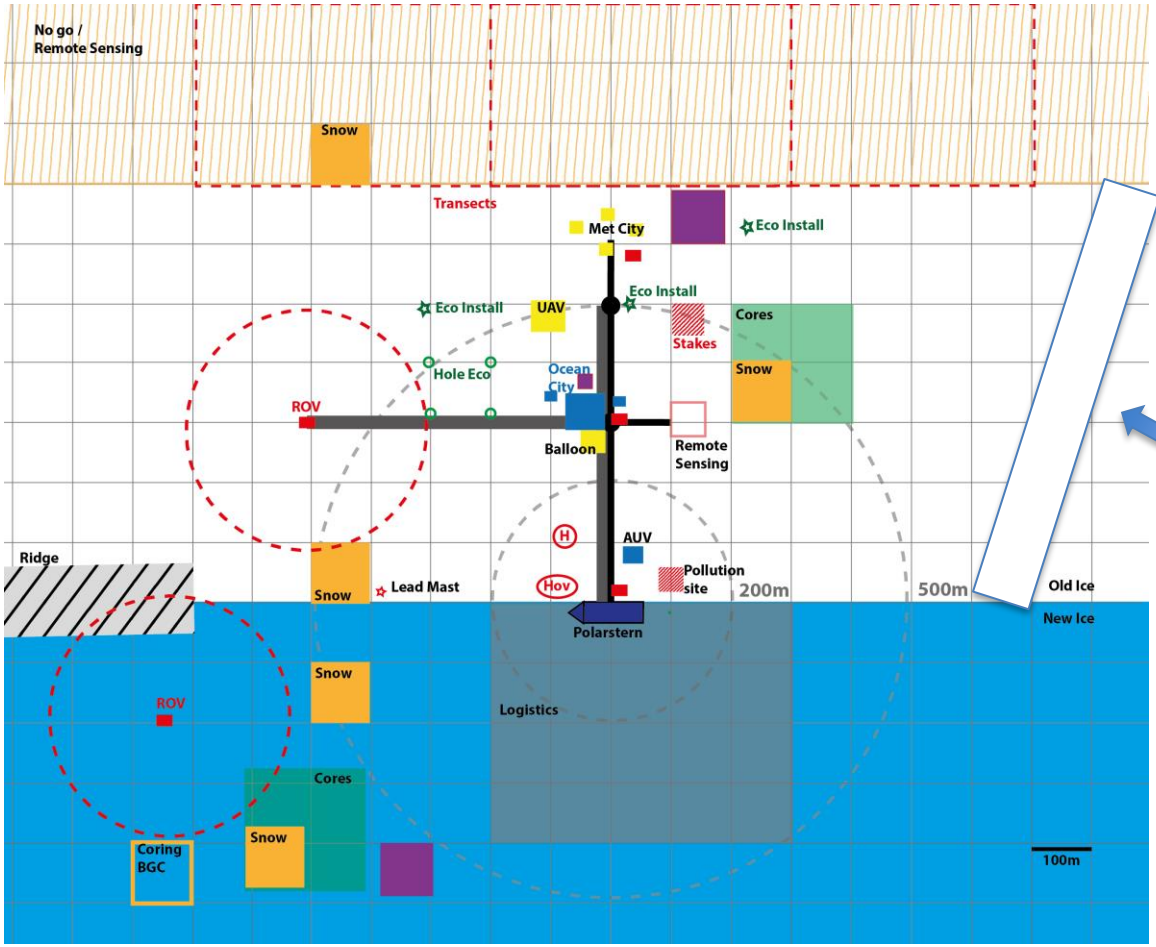
24 April – 15 May 2020

SUMMER (50 h)

31 July – 17 August 2020

Total flight hours, including Ferry- and Test flights: 500 h

POLARSTERN AREA



© Marcel Nicolaus, AWI

Met, Ocean, ECO, BGC, ICE sites - close to RV Polarstern, depends on snow and ice conditions

Runway specification:

- UTAir (length-width-thick): 1400 m / 35 m / 1 m (reduced payload)
- KBAL (length-width-thick): 1200 m / 28 m / 1 m
- Distance from ship at least 1 – 2 km

MOSAiC and YOPP

Stockholm University

- An opportunity for understanding and improving models – process understanding and verification/evaluation
- Motivated to the funders by model improvement
- Coupled NWP models, need for new evaluation methods and data

MOSAiC and YOPP science

Stockholm University

MOSAiC leading question: What are the causes and consequences of an evolving and diminished Arctic sea ice cover?

YOPP SOP-NH3

Airmass transformations i.e. advection from over open water $\rightarrow$ sea ice & sea ice $\rightarrow$ open water

Processes important during:

- warm(and moist) air intrusions
- cold-air outbreaks

Planned YOPP activities

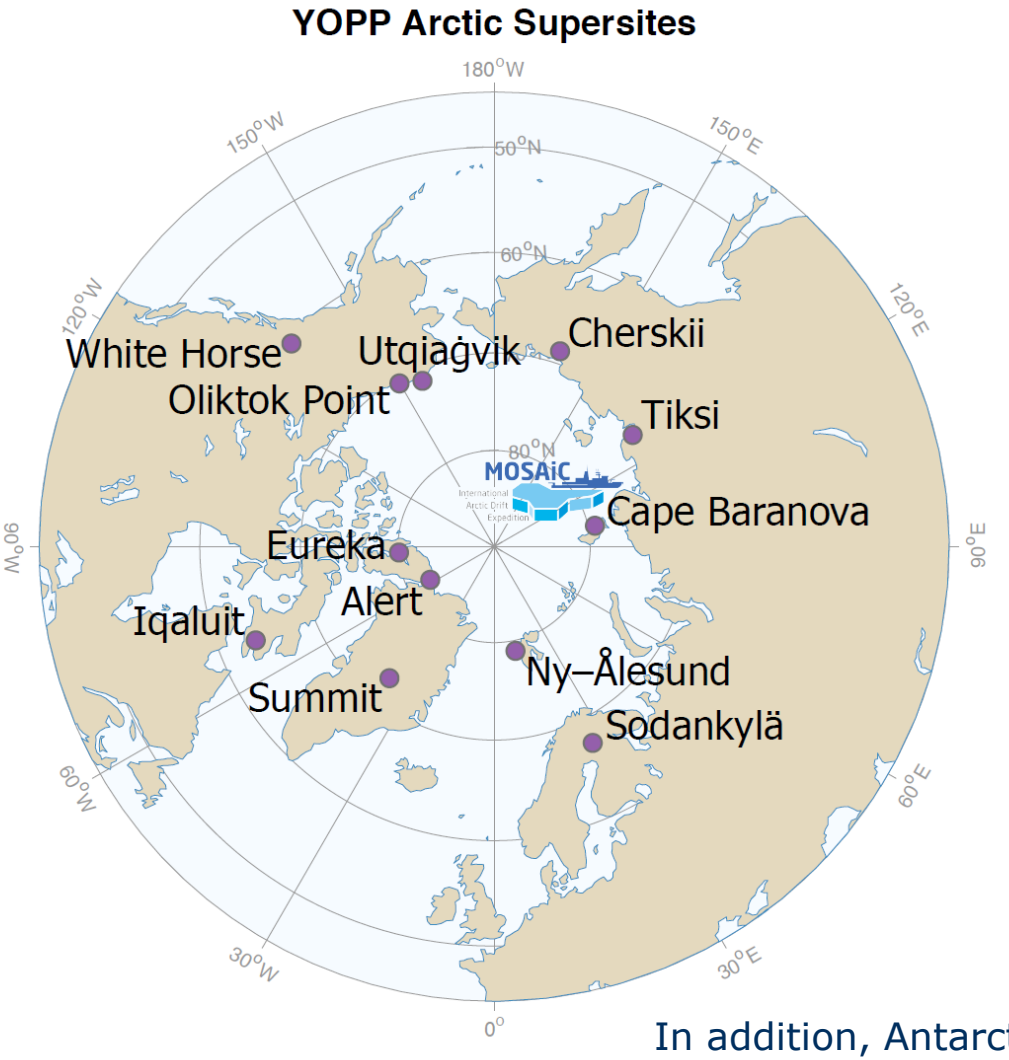
Stockholm University

- Accelerate access to data, i.e. ocean and ice data on GTS and YOPPsiteMIP include MOSAiC central site
- Coordinated extra soundings at existing stations
- NWP support for flight planning
- Aircraft Polar 5 & 6, including dropsonds
- NOAA P3? (March or April, not confirmed yet)
- COMBLE (Cold-air Outbreaks in the Marine Boundary Layer) ARM Mobile Facility at Northern Norway and Bear Island (1 Jan – 31 May)
- Oden re-supplies: Tromsö – Polarstern (twice during June)
- …

YOPPsiteMIP

Year of Polar Prediction supersite Model Inter-comparison Project

Stockholm University



Supersites: Suites of instruments measuring variables that lead to ***process understanding***

Models: ***High frequency*** column output on ***model levels*** at supersites

MIP: Developed ***Format and Semantics*** used for both models and observations promoting ***multimodel*** and ***multisite*** verification and ***process evaluation***

Data: Available through the ***YOPP Data Portal*** (yopp.met.no)

Targeted processes: Low level clouds (including phase), Stable boundary layers, Atmosphere-snow interactions over land and sea-ice, Coupling procedures (variables and frequencies), Ocean mixing, …

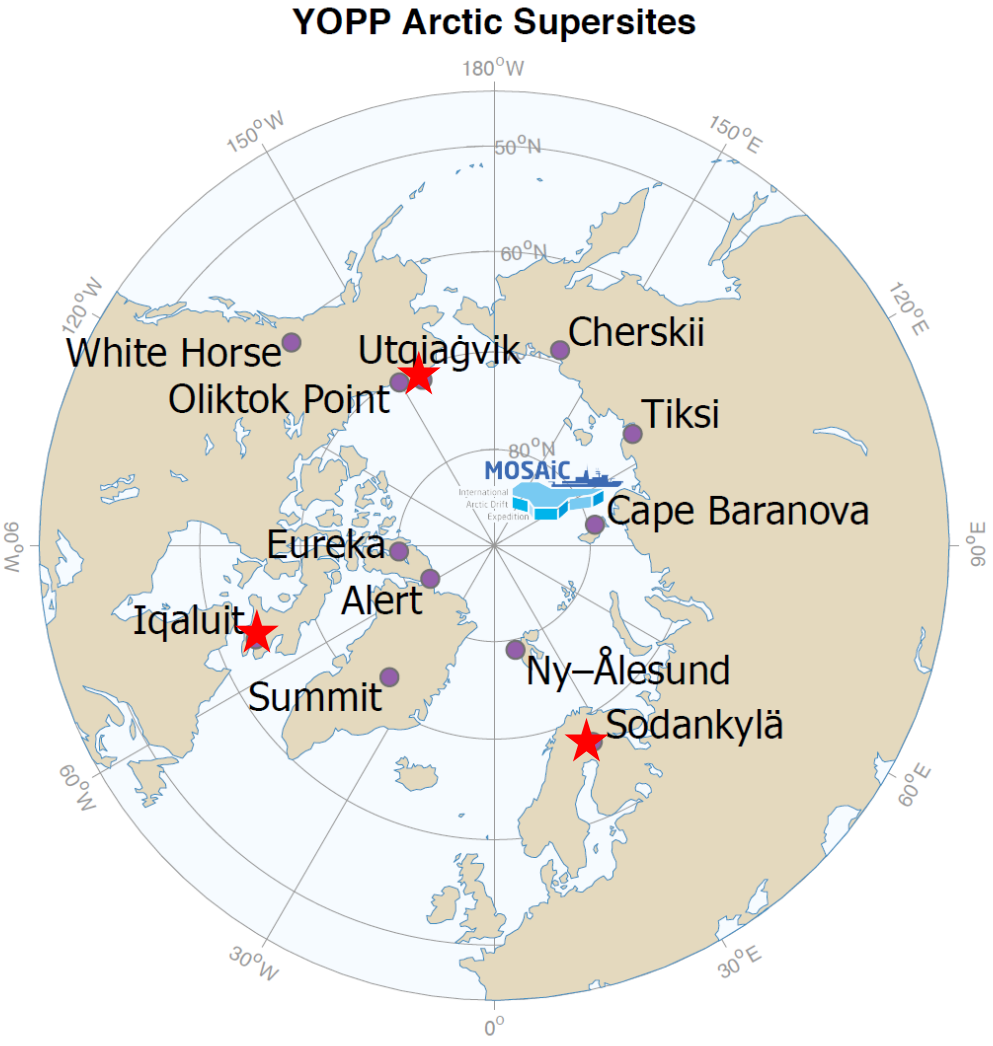
In addition, Antarctic and Third Pole sites

YOPP YEAR OF POLAR PREDICTION

YOPPsiteMIP

Year of Polar Prediction supersite Model Inter-comparison Project

Stockholm University



Models: DWD, ECCC, ECMWF, FMI, MetNorway, MetOffice, NOAA/NECP, MeteoFrance, Russian Met, CORDEX, CESM, …

★ initial focus

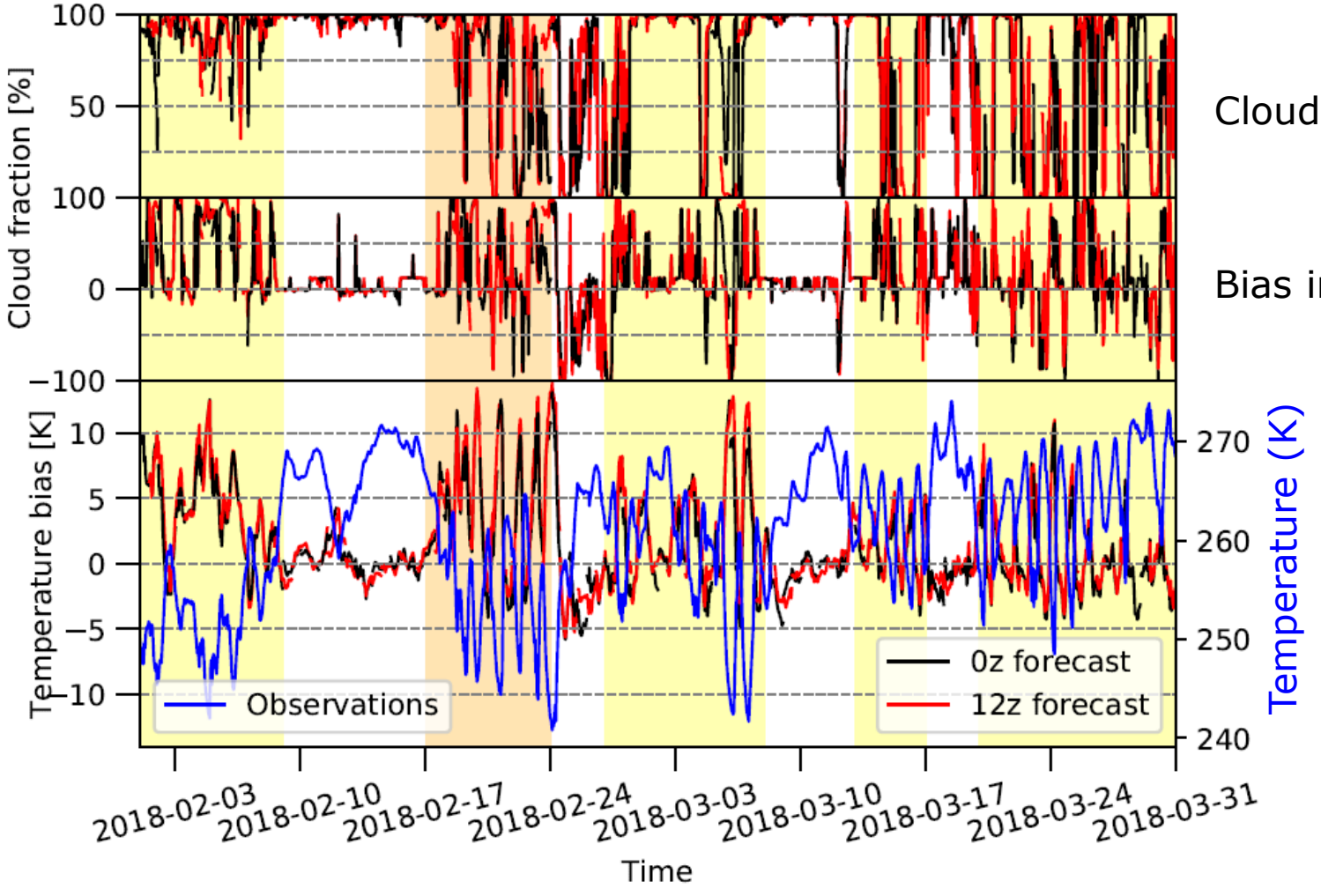
For MOSAiC, plans are to have observational and model files ready 1 month after each of the 6, 2-3 month long legs

YOPP YEAR OF POLAR PREDICTION

YOPPsiteMIP

ECMWF IFS @ Sodankylä for SOP-NH1 (1 Feb—31 Mar2018)

Stockholm University



Cloud fraction

Bias in cloud fraction

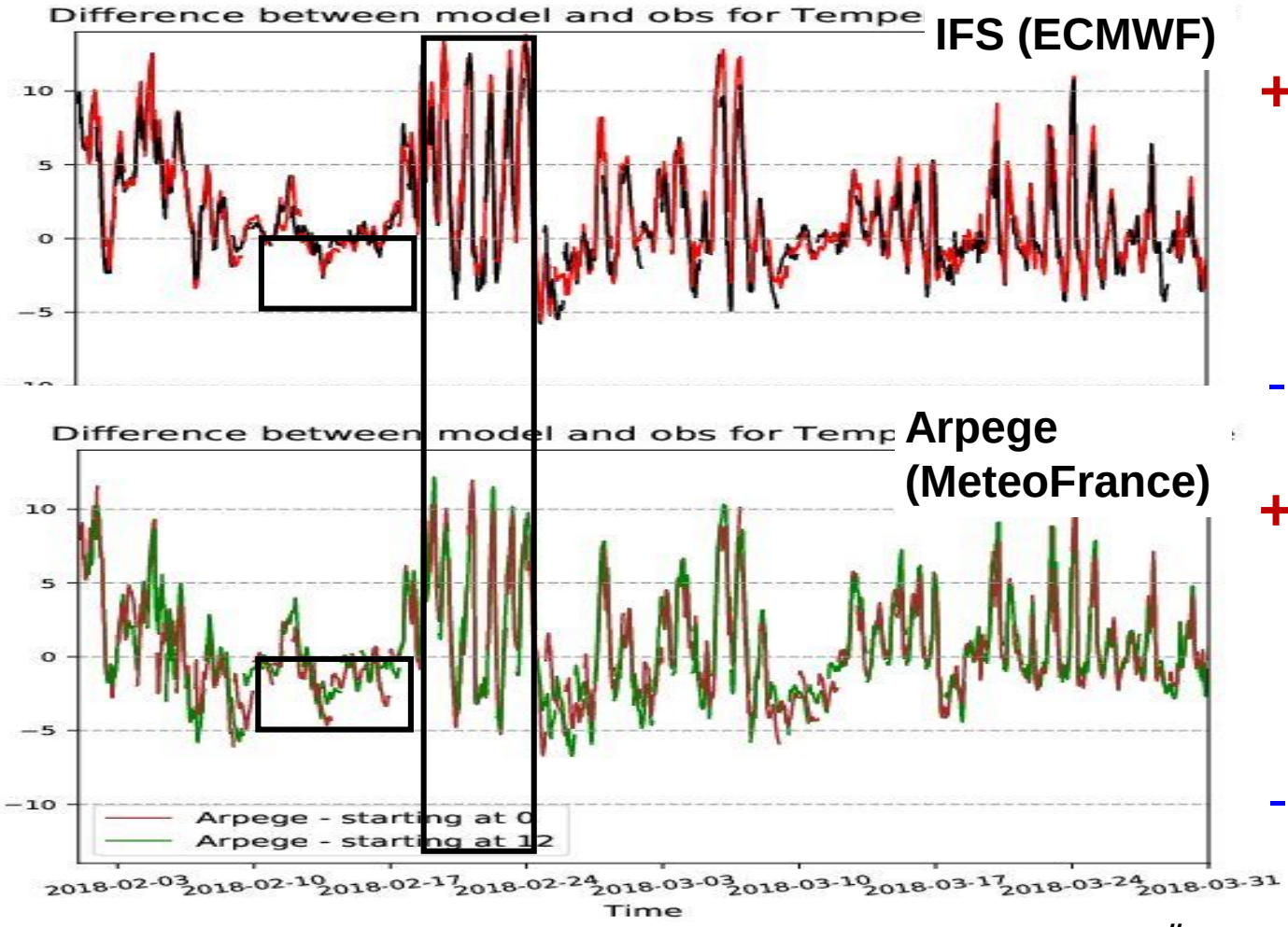
Courtesy Eiríkur Örn Jóhannesson Stockholm University

YOPP YEAR OF POLAR PREDICTION

YOPPsiteMIP

Easy to evaluate many models @ several locations

Stockholm University



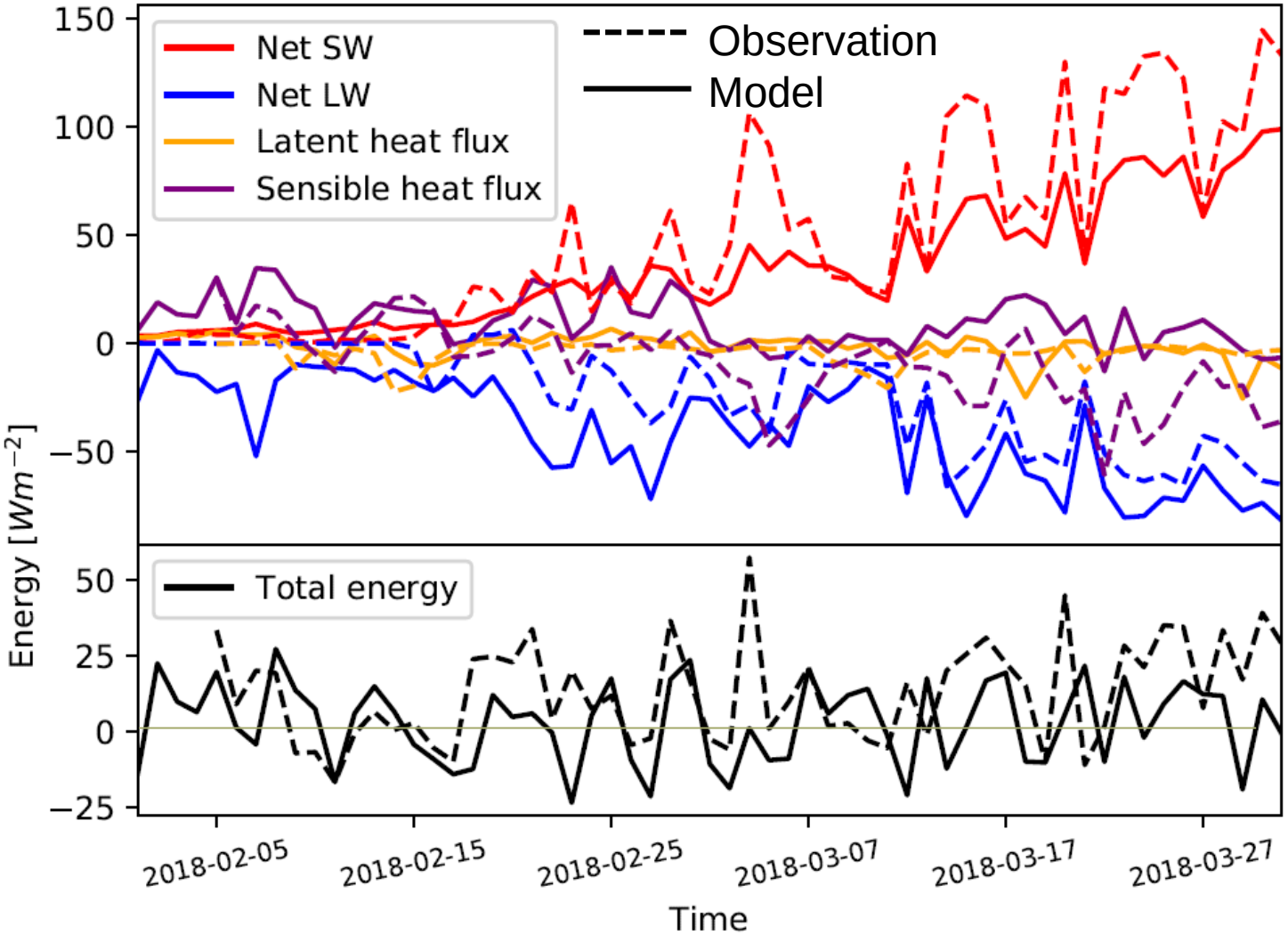
Courtesy Eiríkur Örn Jóhannesson
Stockholm University

YOPP YEAR OF POLAR PREDICTION

YOPPsiteMIP

ECMWF IFS @ Sodankylä for SOP-NH1 (1 Feb—31 Mar2018)

Stockholm University



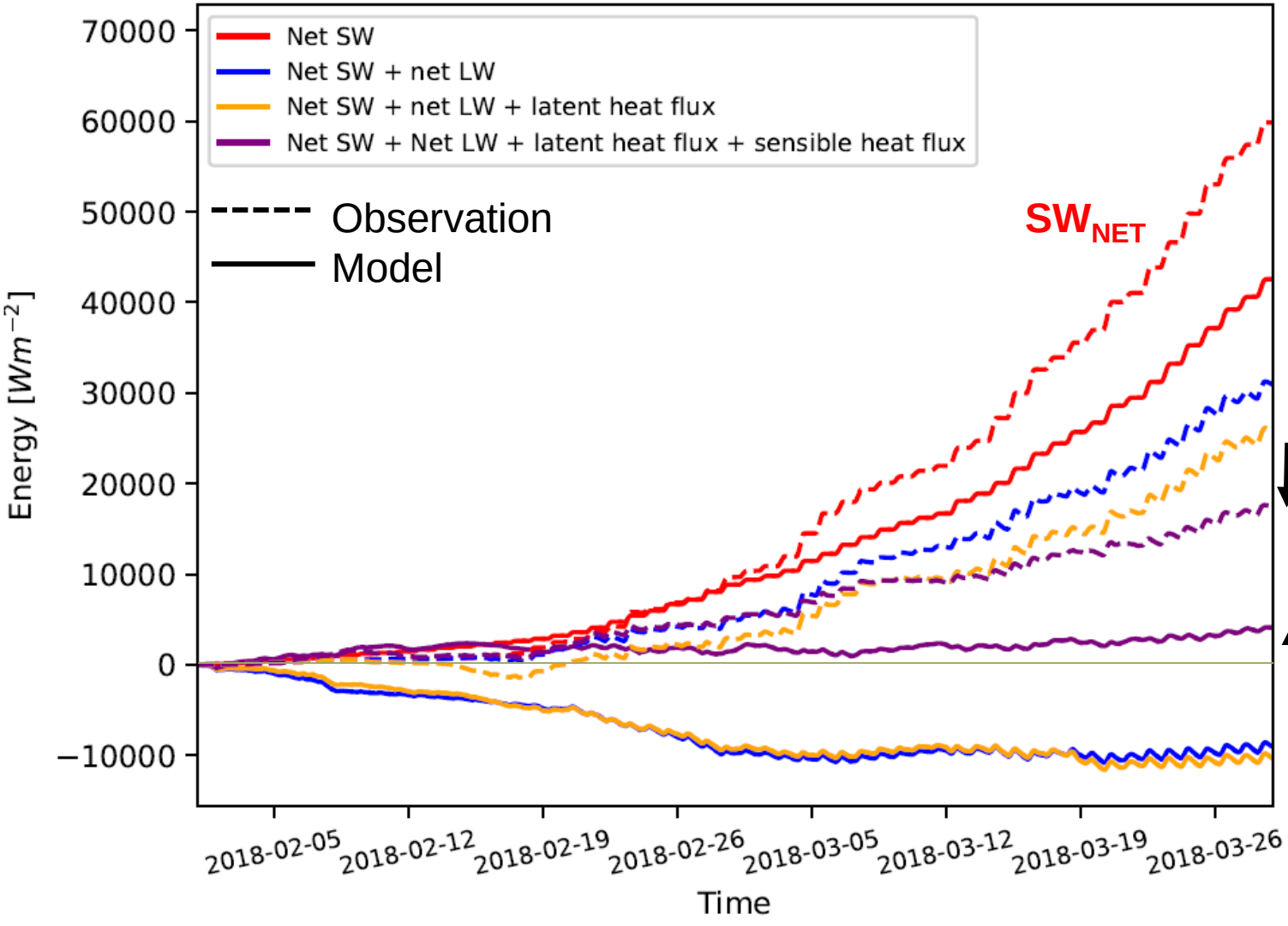
Courtesy Eiríkur Örn Jóhannesson Stockholm University

YOPP YEAR OF POLAR PREDICTION

YOPPsiteMIP

ECMWF IFS @ Sodankylä for SOP-NH1 (1 Feb—31 Mar2018)

Stockholm University

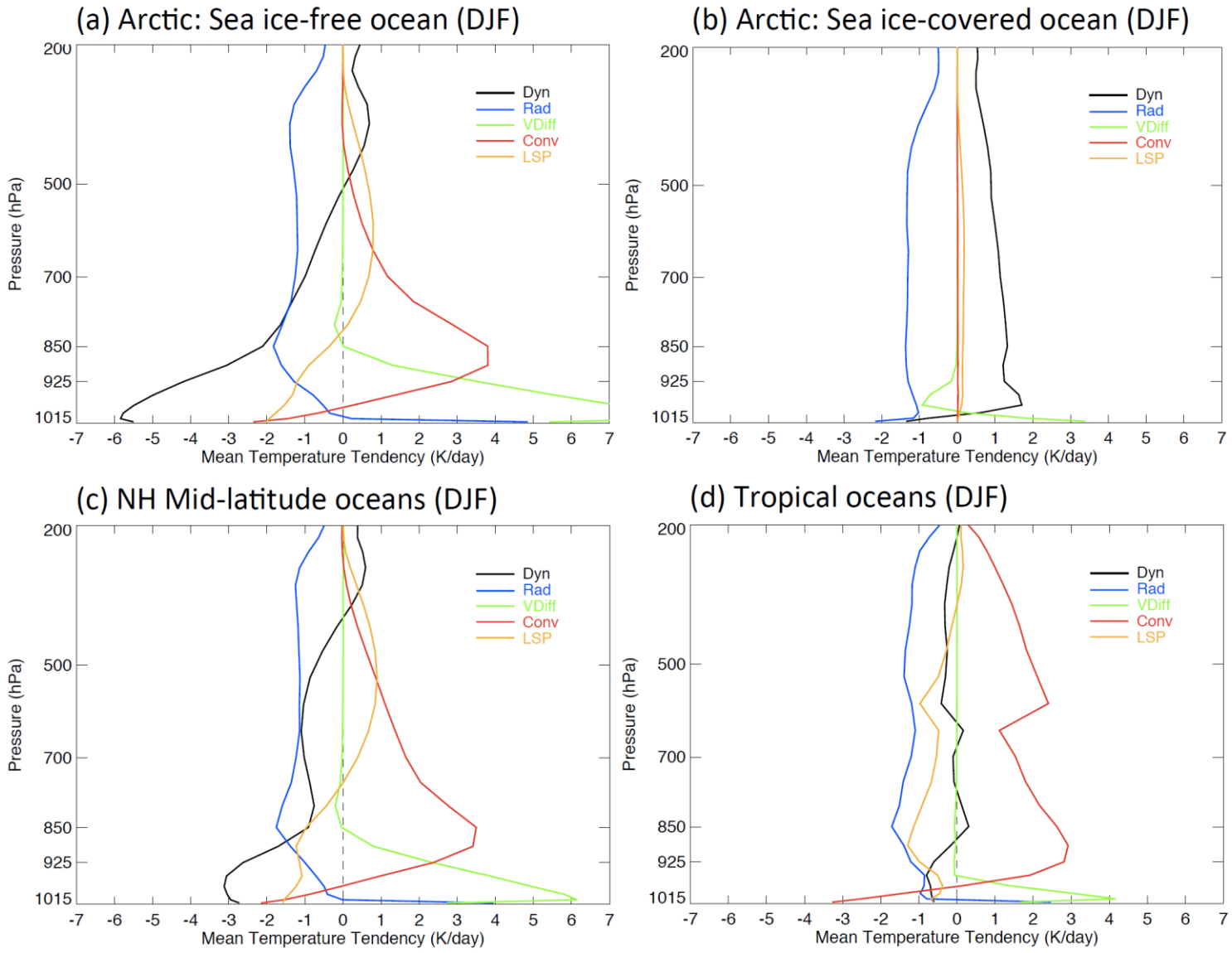


Courtesy Eiríkur Örn Jóhannesson Stockholm University

YOPP YEAR OF POLAR PREDICTION

Physical processes and dynamics
Averaged initial tendencies of temperature (IFS)

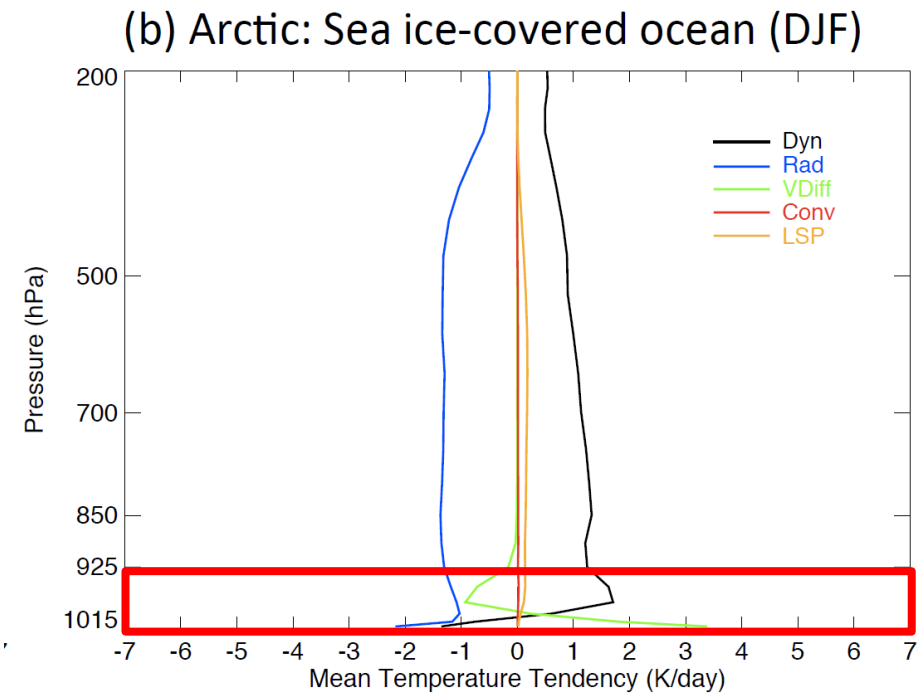
Stockholm University



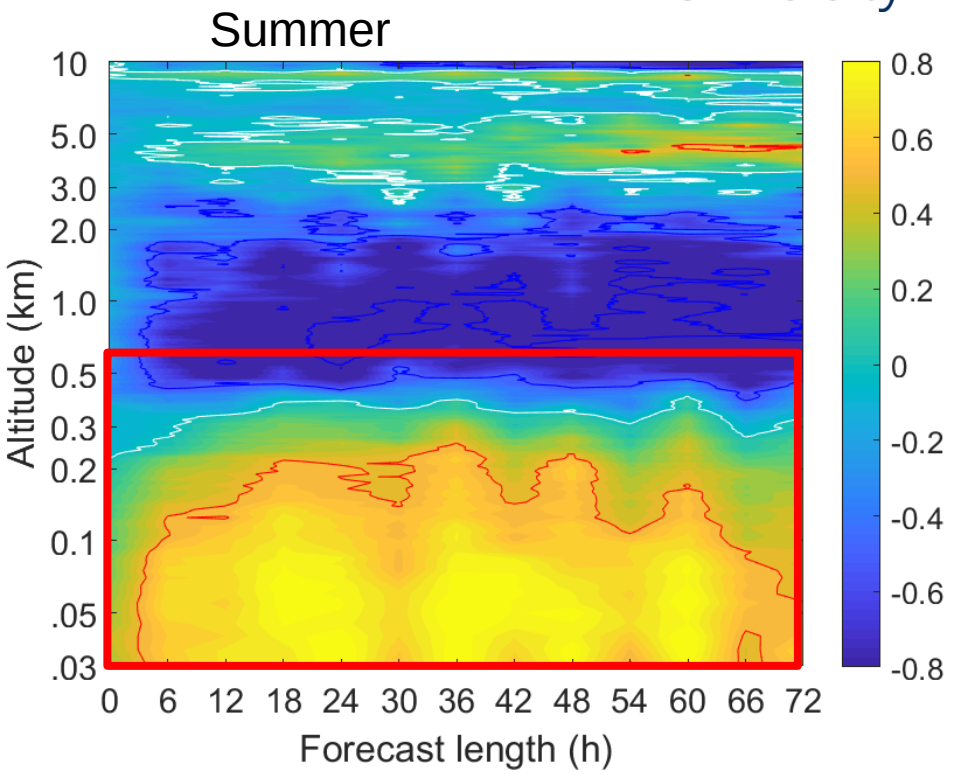
Jung et al. 2015

IFS over the Arctic Ocean

Stockholm University

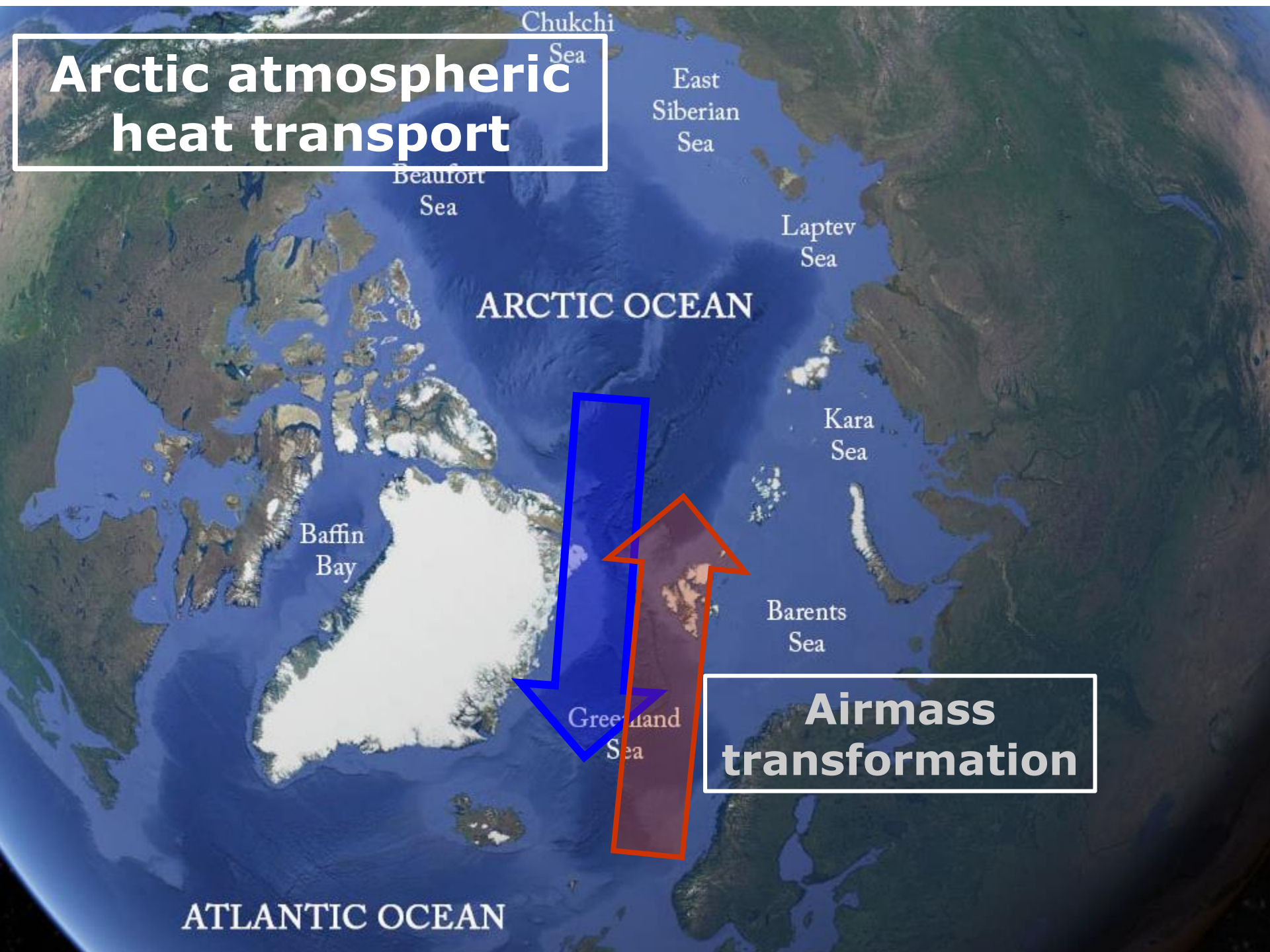


Jung et al. 2015



From M. Tjernström's talk

Biases in parameterisations may develop for long periods due to the lack of diurnal cycle

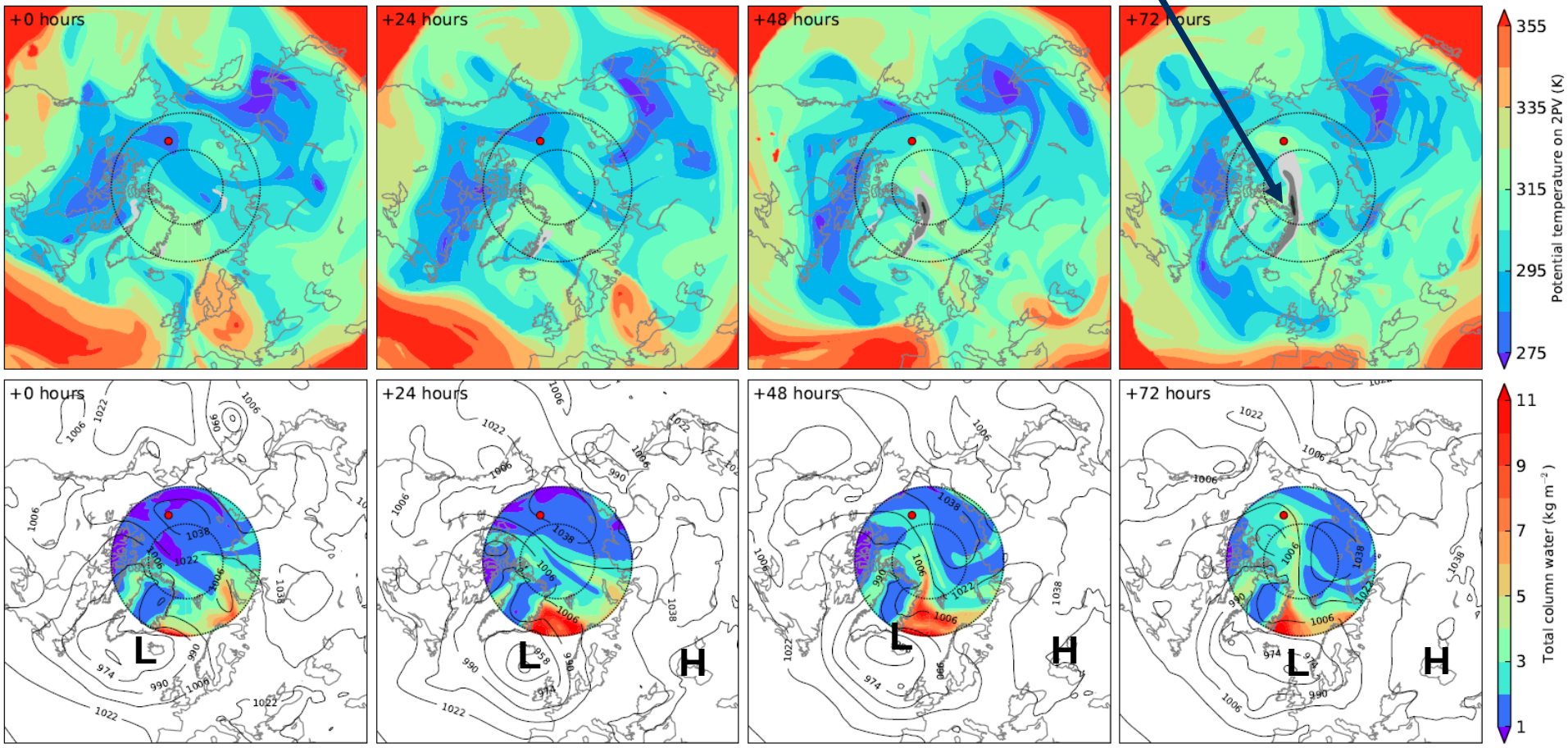

Arctic atmospheric heat transport
Chukchi Sea
East Siberian Sea
Beaufort Sea
Laptev Sea
ARCTIC OCEAN
Kara Sea
Baffin Bay
Barents Sea
Greenland Sea
Airmass transformation
ATLANTIC OCEAN

Intrusion event
1 jan 1998

Black area
+15-20 K

Stockholm University

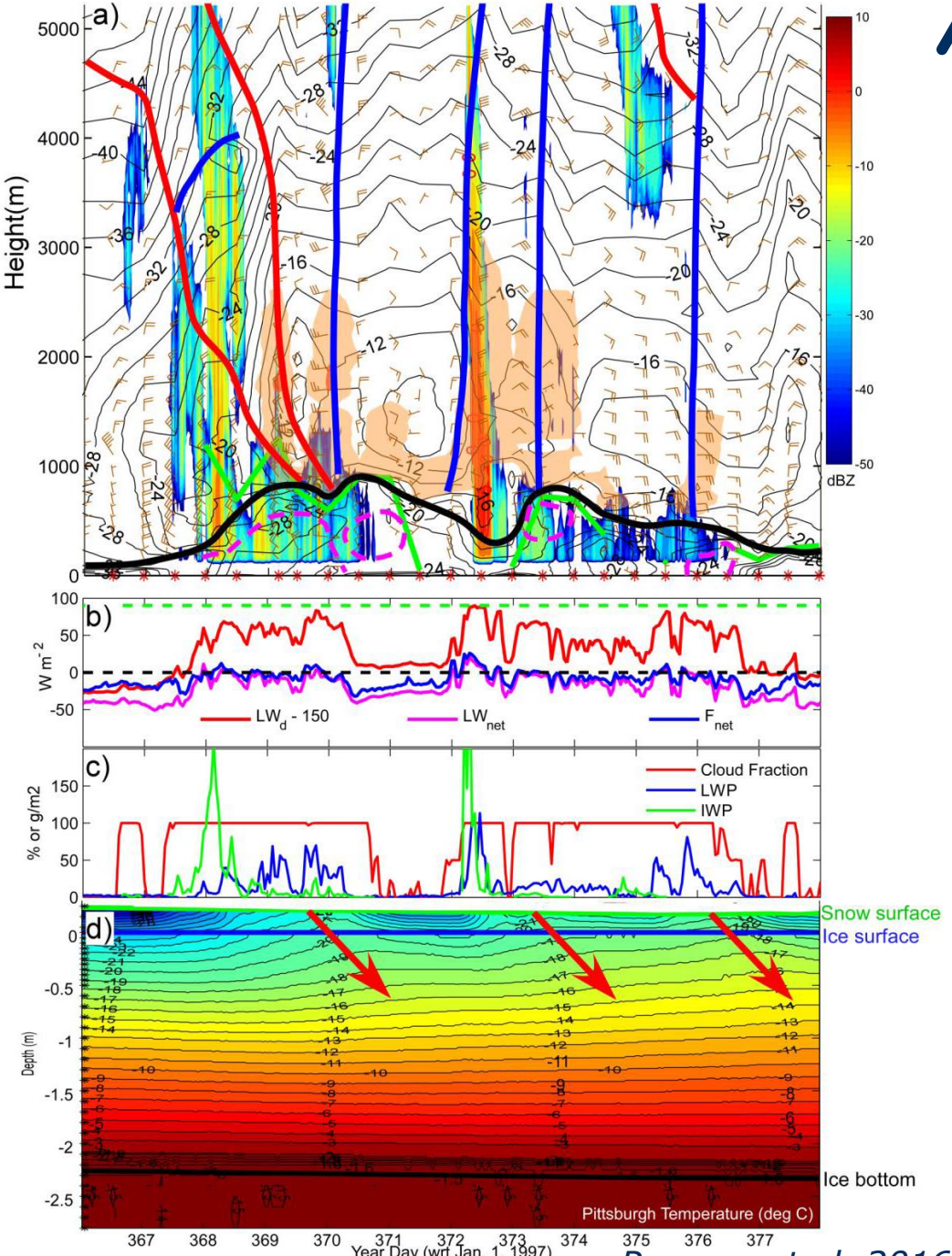
Potential temperature on 2PV

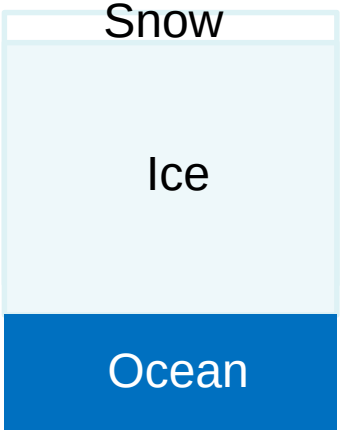


Sea level pressure and precipitable water

Woods, Caballero and Svensson 2013

Surface response of synoptic events





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Surface Energy Budget

Stockholm University

Persson et al. 2016

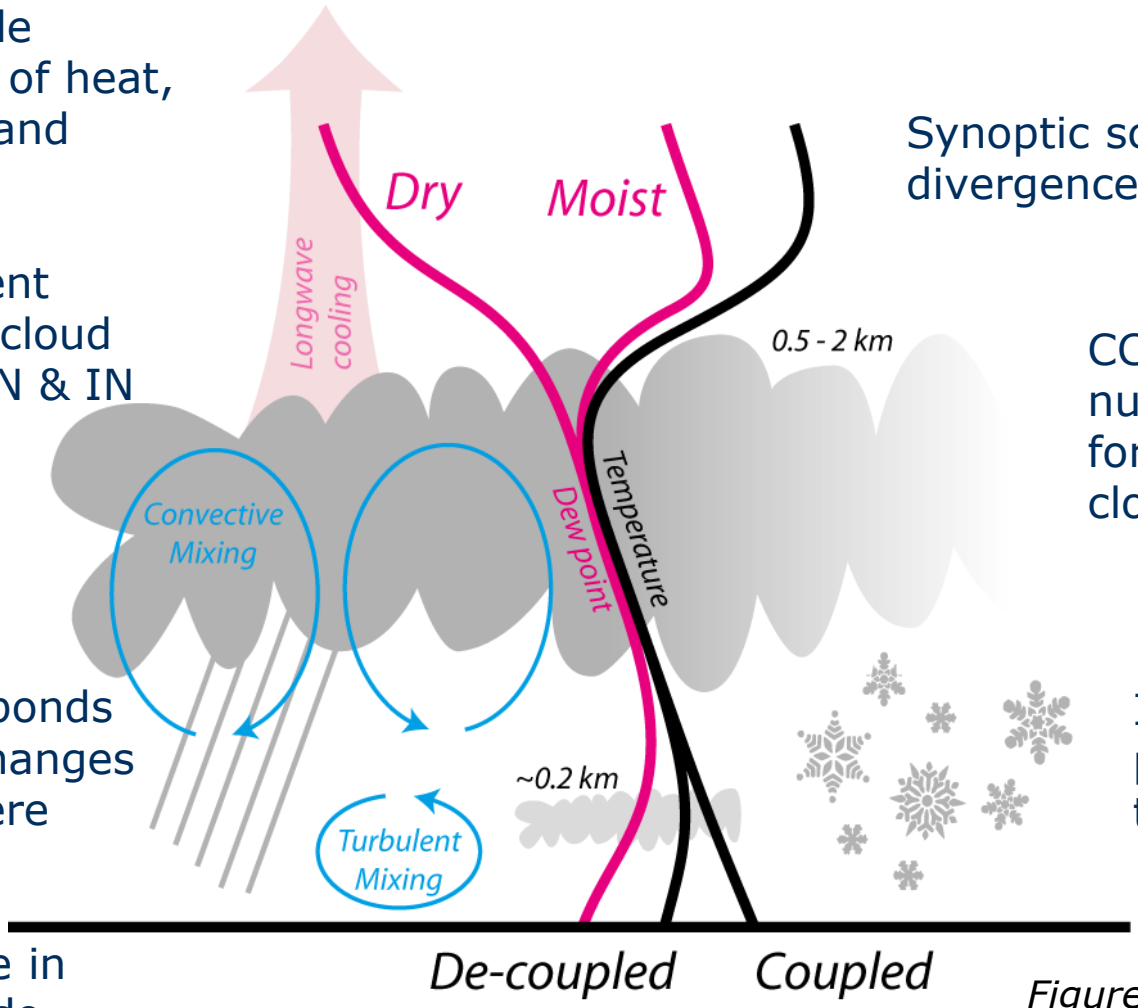
Mixed-phase clouds

Delicate balance between many processes

Stockholm University

Large-scale advection of heat, moisture and aerosols

Entrainment source of cloud water, CCN & IN



Synoptic scale divergence

CCN (cloud droplet number) important for lifetime of liquid clouds

Surface responds rapidly to changes in atmosphere

Ice particles precipitate out of the liquid cloud

Temperature in winter, albedo during melt

Surface fluxes mostly small and less important

Figure by T. Mauritsen

Airmass transformation

Transport in over sea ice in winter

Stockholm University

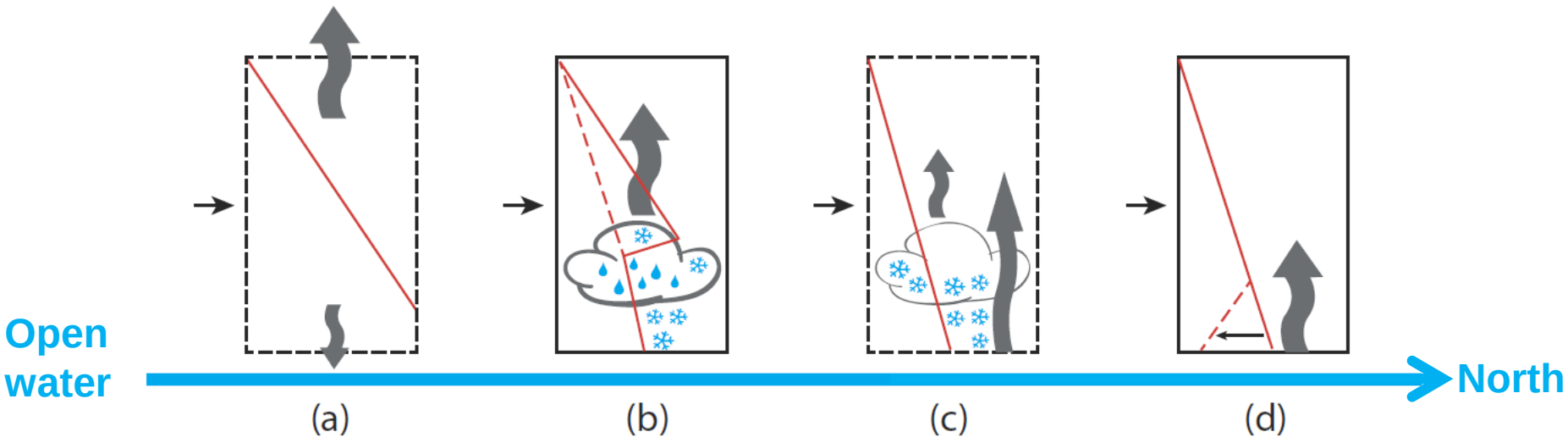
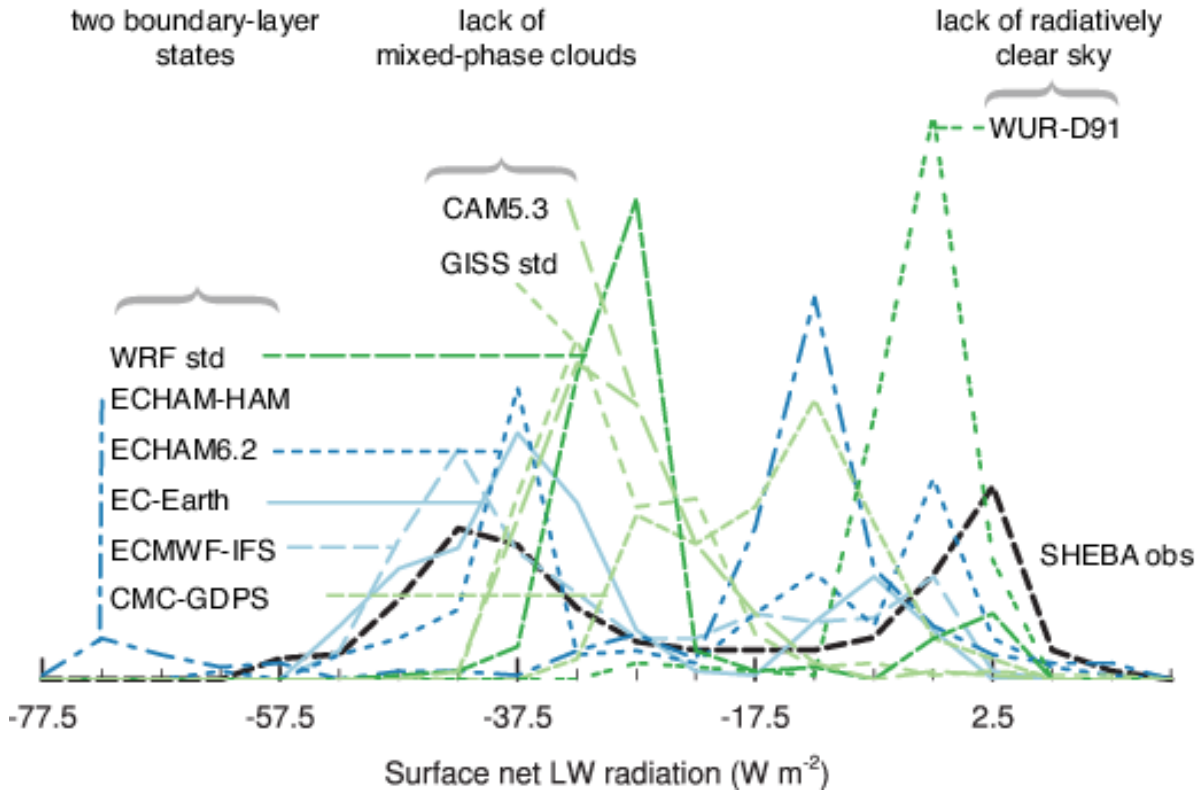


Fig. 6 Sketch of the formation of Arctic air. Dashed boxes mark unstable transition states.

Pithan et al., 2013

Polar airmass transition
GASS SCM model intercomparison

Stockholm University

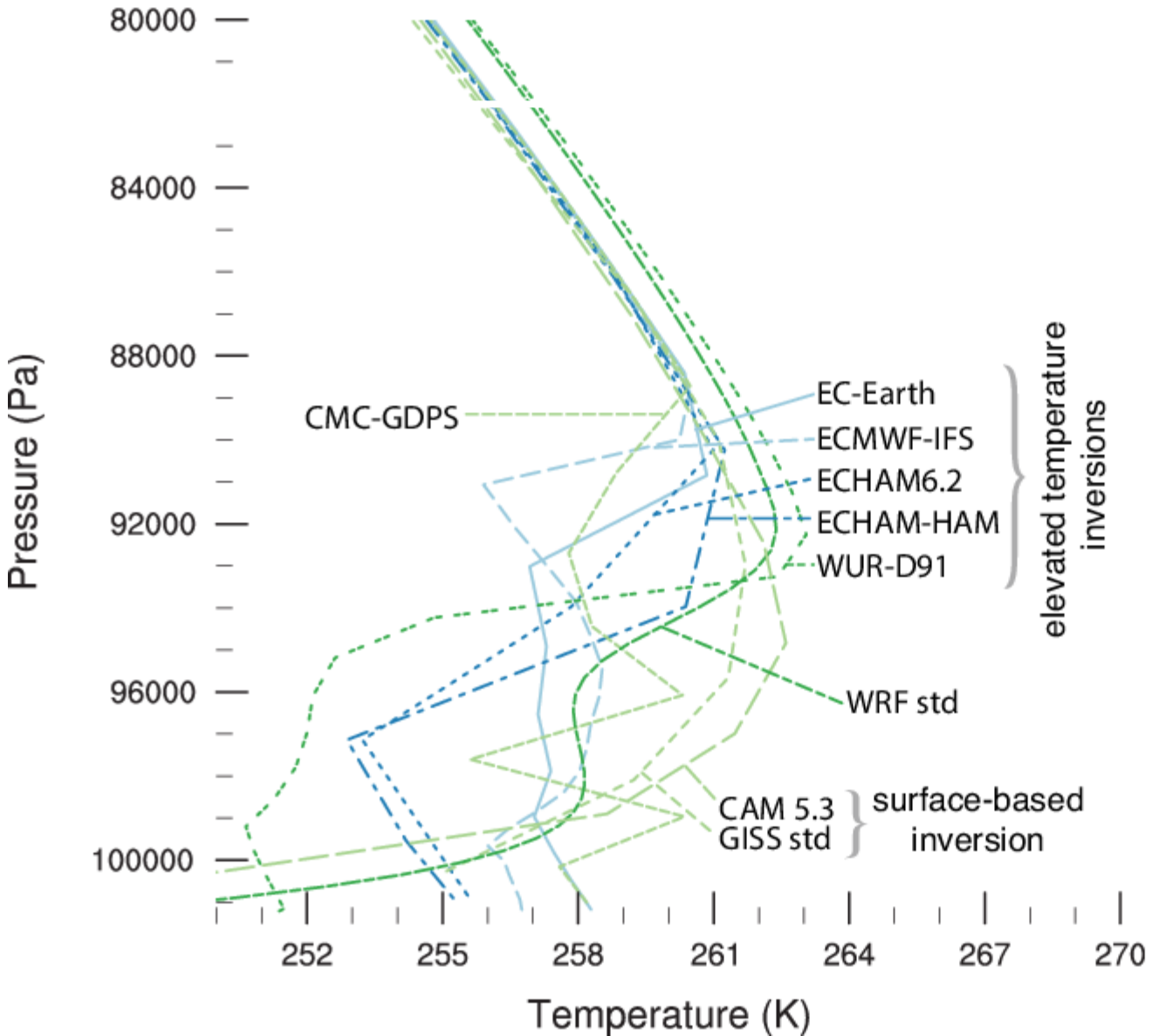


GASS GEWEX WCRP Global Atmospheric System Studies

Pithan et al., 2016

Polar airmass transition

GASS SCM model intercomparison

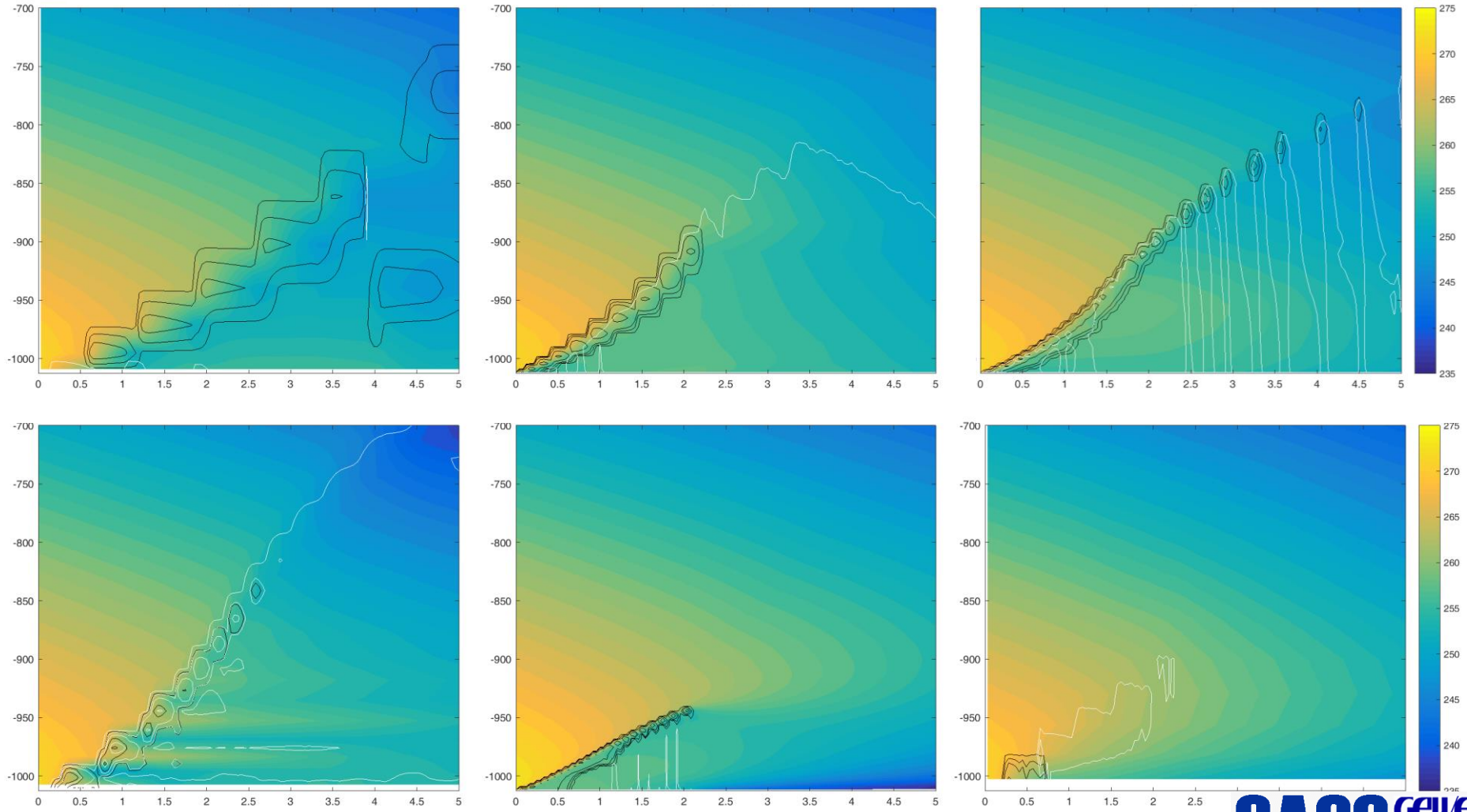


Pithan et al., 2016

Polar airmass transition

GASS SCM model intercomparison

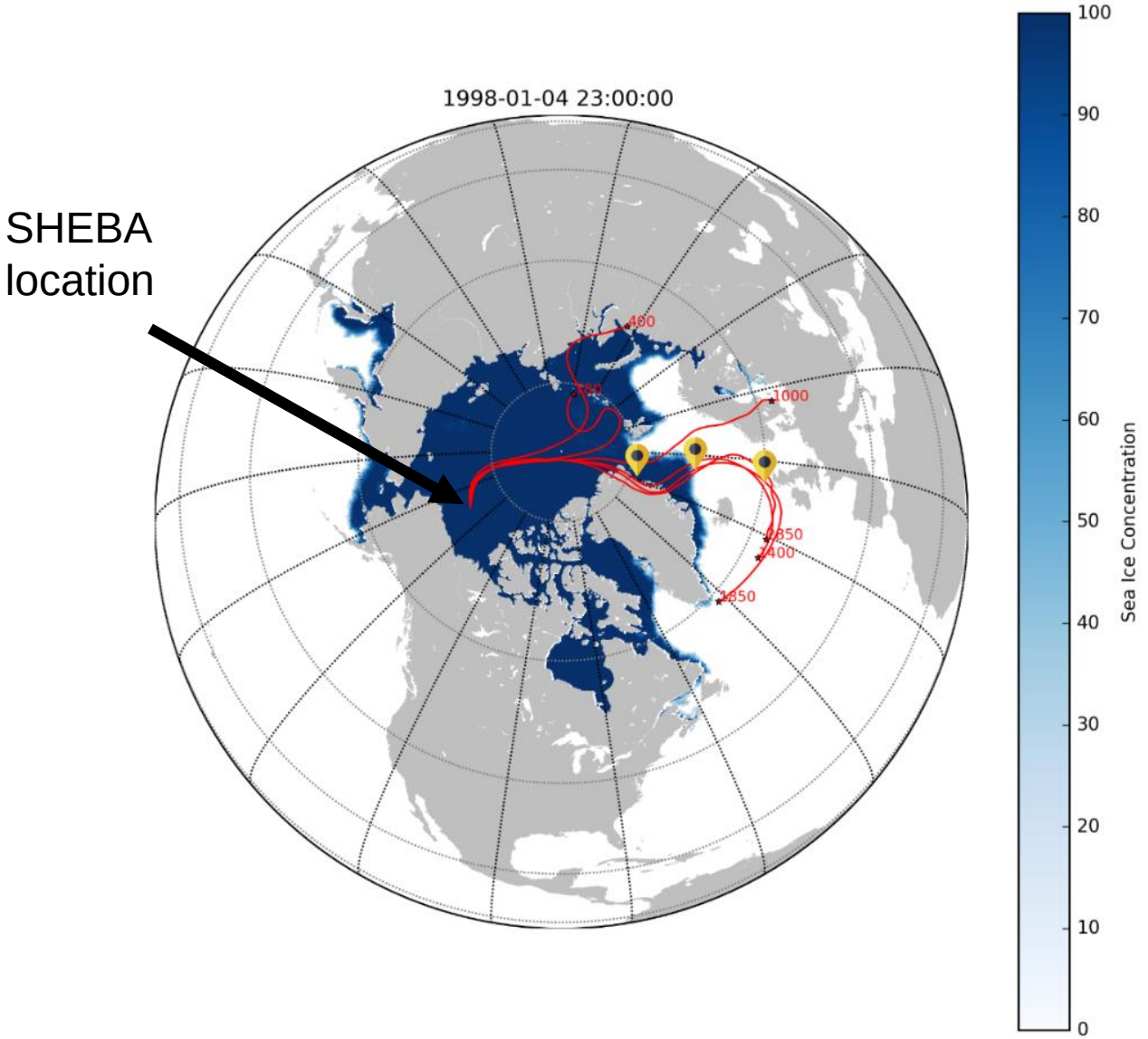
Stockholm University



GASS GEWEX WCRP Global Atmospheric System Studies

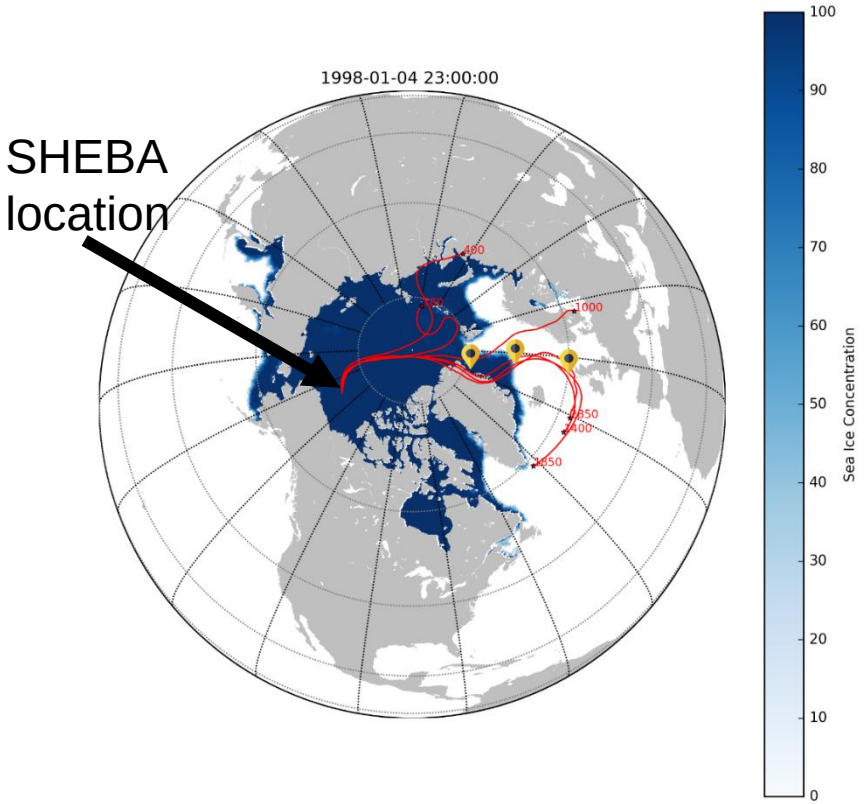
Airmass passing over observational locations

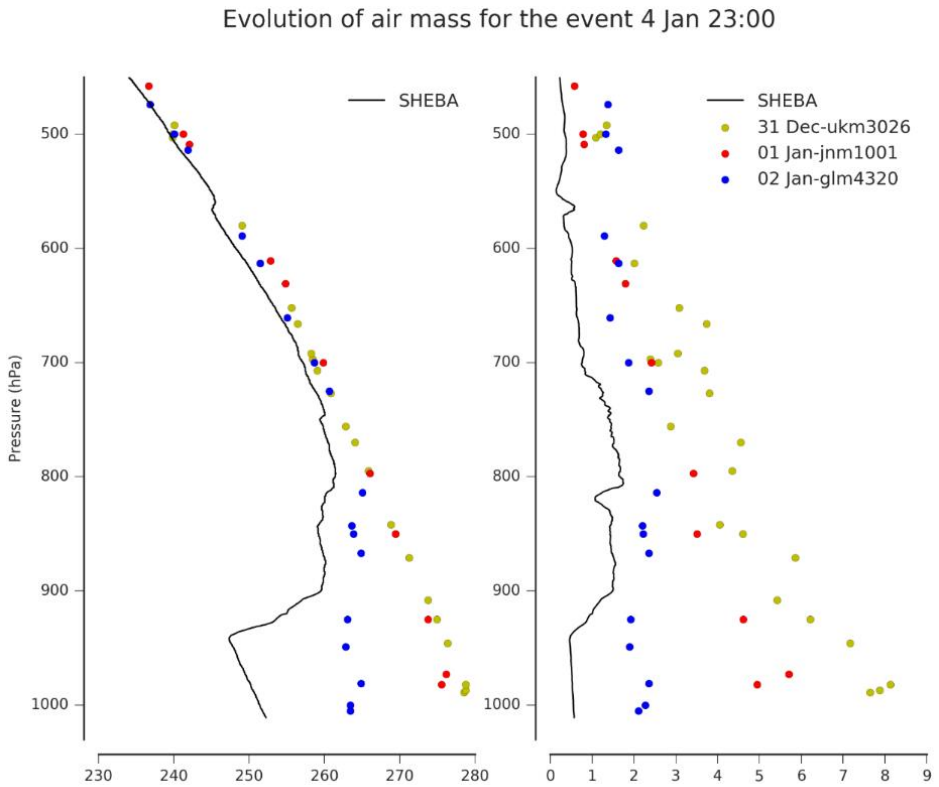
Stockholm University



Courtesy Felix Pithan and Syed Mubashshir Ali

Airmass passing over observational locations





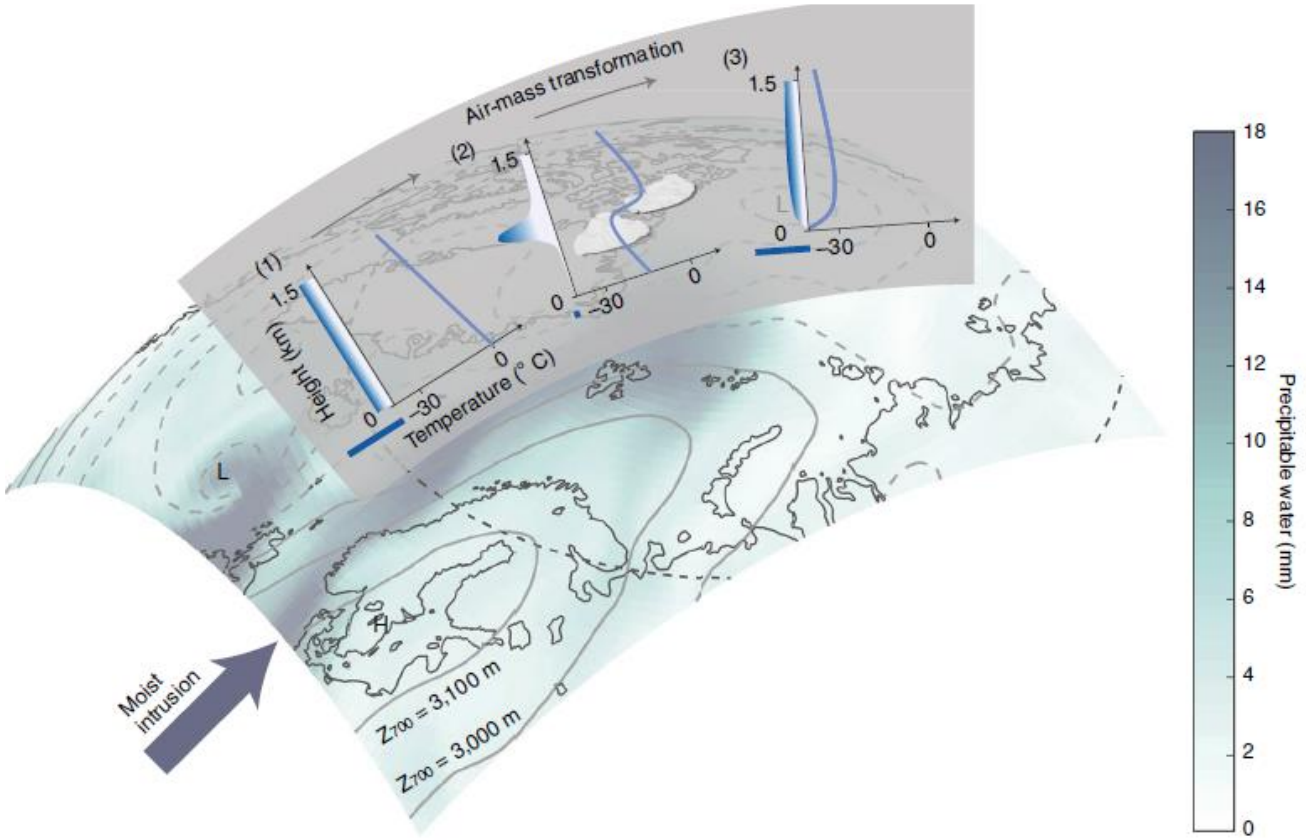
Temperature (K)

Specific humidity (g kg^{-1})

Courtesy Felix Pithan and Syed Mubashshir Ali

Airmass transformation

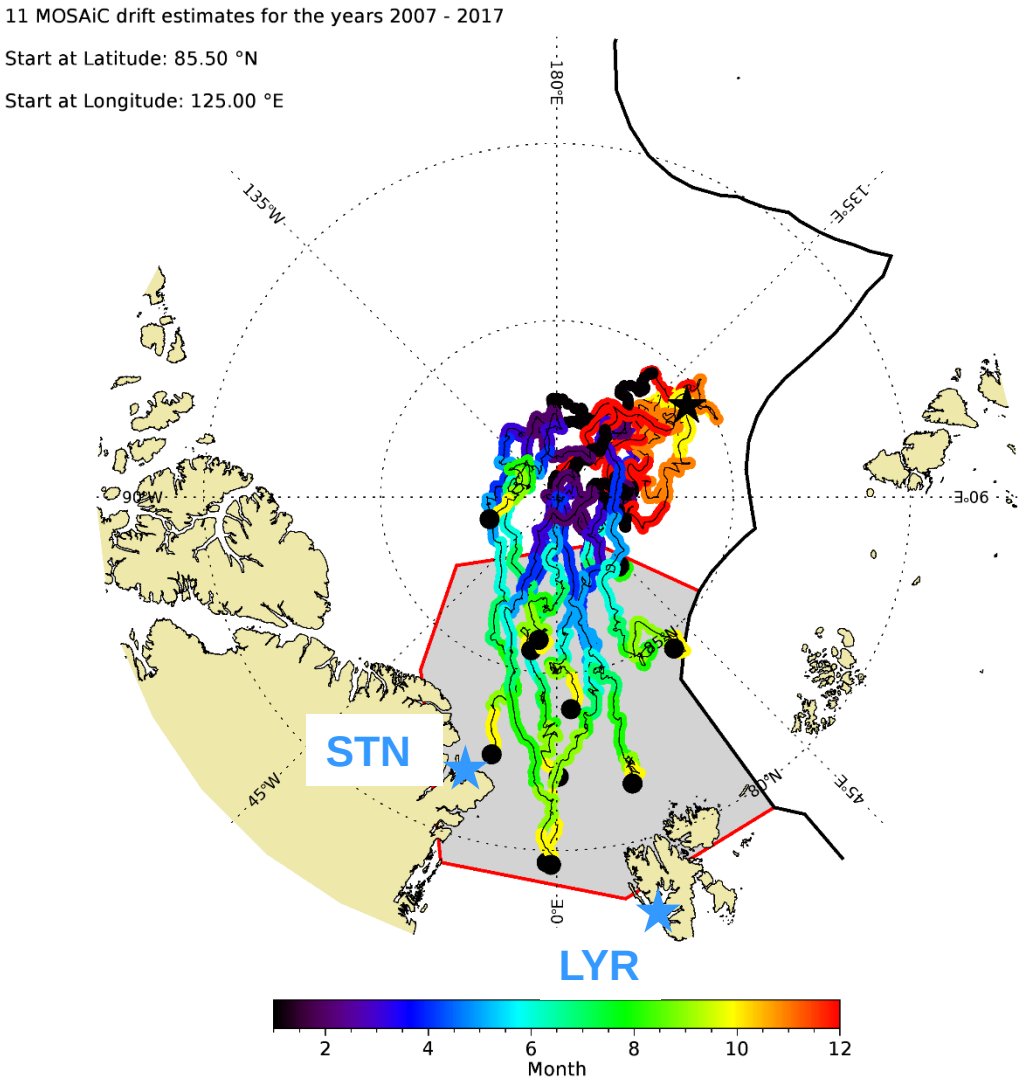
Warm-air advection, Lagrangian perspective



Pithan, F., G. Svensson, R. Caballero, D. Chechin, T.W. Cronin, A.M.L. Ekman, R. Neggers, M.D. Shupe, A. Solomon, M. Tjernström, and M. Wendisch, 2018: Role of air-mass transformations in exchange between the Arctic and mid-latitudes, Nature Geoscience, doi:10.1038/s41561-018-0234-1

Where will Polarstern be in March 2020?

Stockholm University



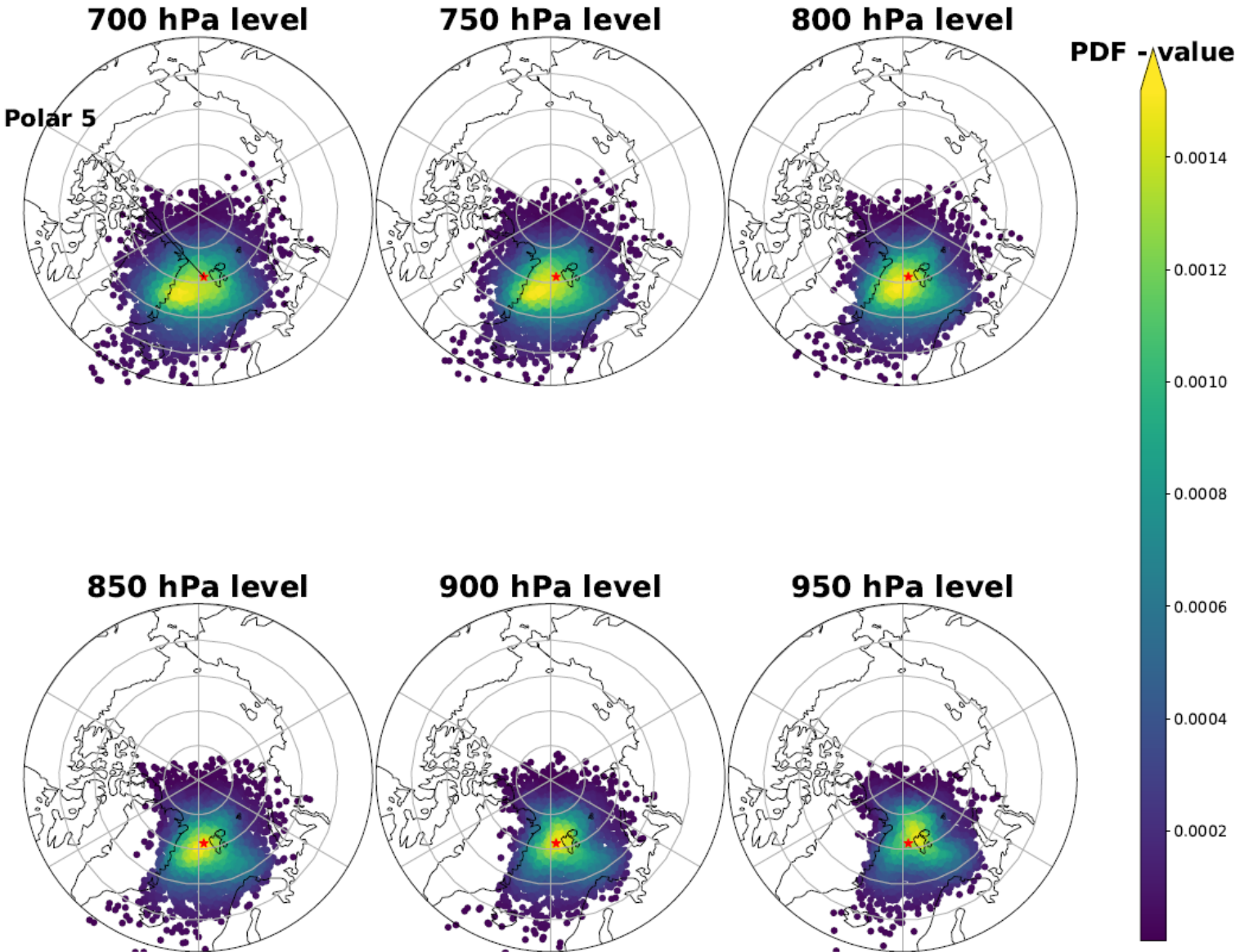
© Thomas Krumpen, AWI

The drift analysis over 11 years show high variability
Longyearbyen (LYR) will be the base but Station Nord (STN) is very important for reaching Polarstern

MOSAiC International Arctic Drift Expedition

1-day backward trajectories for air masses arriving at 79N 5E

Stockholm University

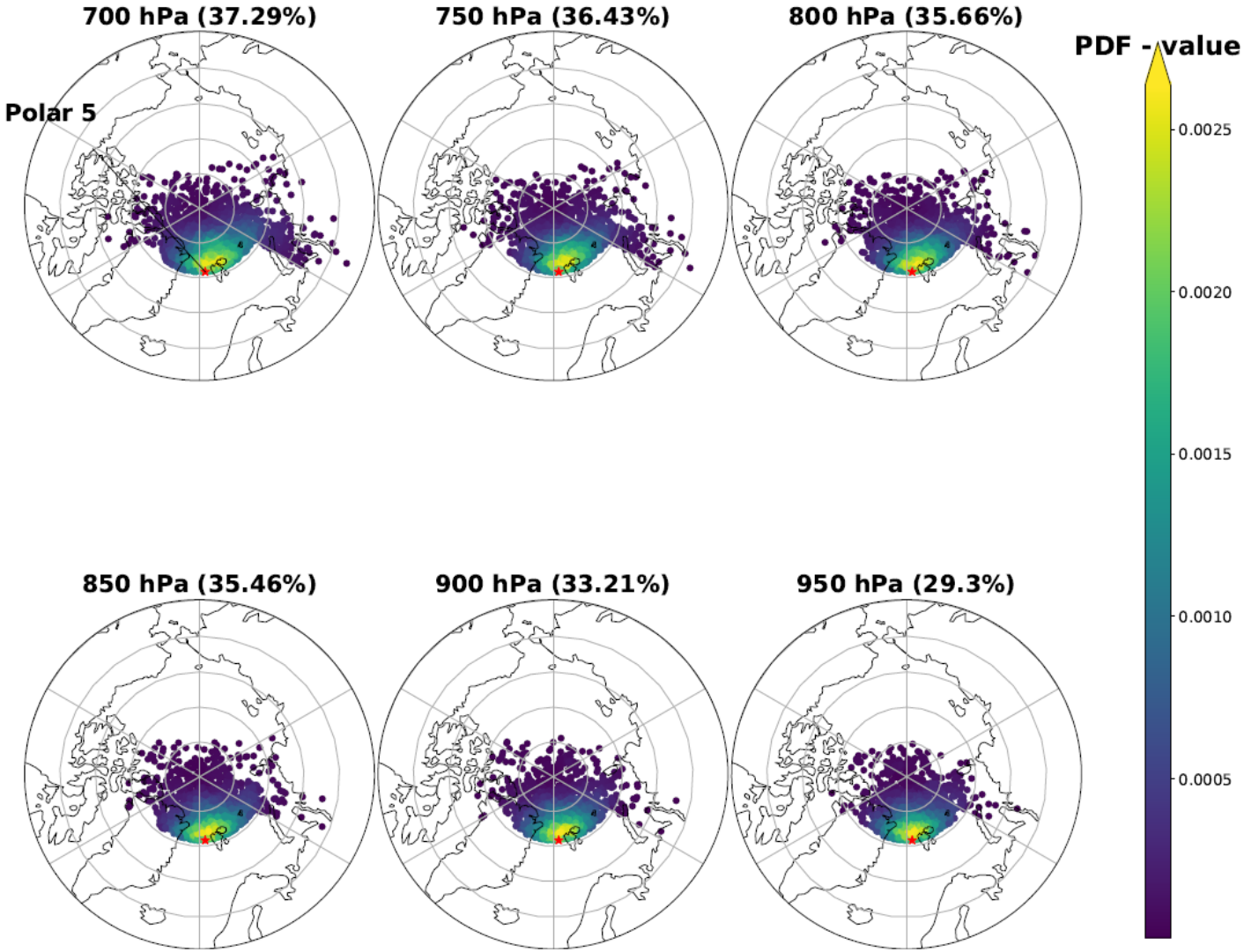


ERA-Interim Climatology (15 March – 15 April, 1979-2017)

Courtesy Sonja Murto, Stockholm University

1-day forward trajectories for air masses starting from 79N 5E and ending over sea ice

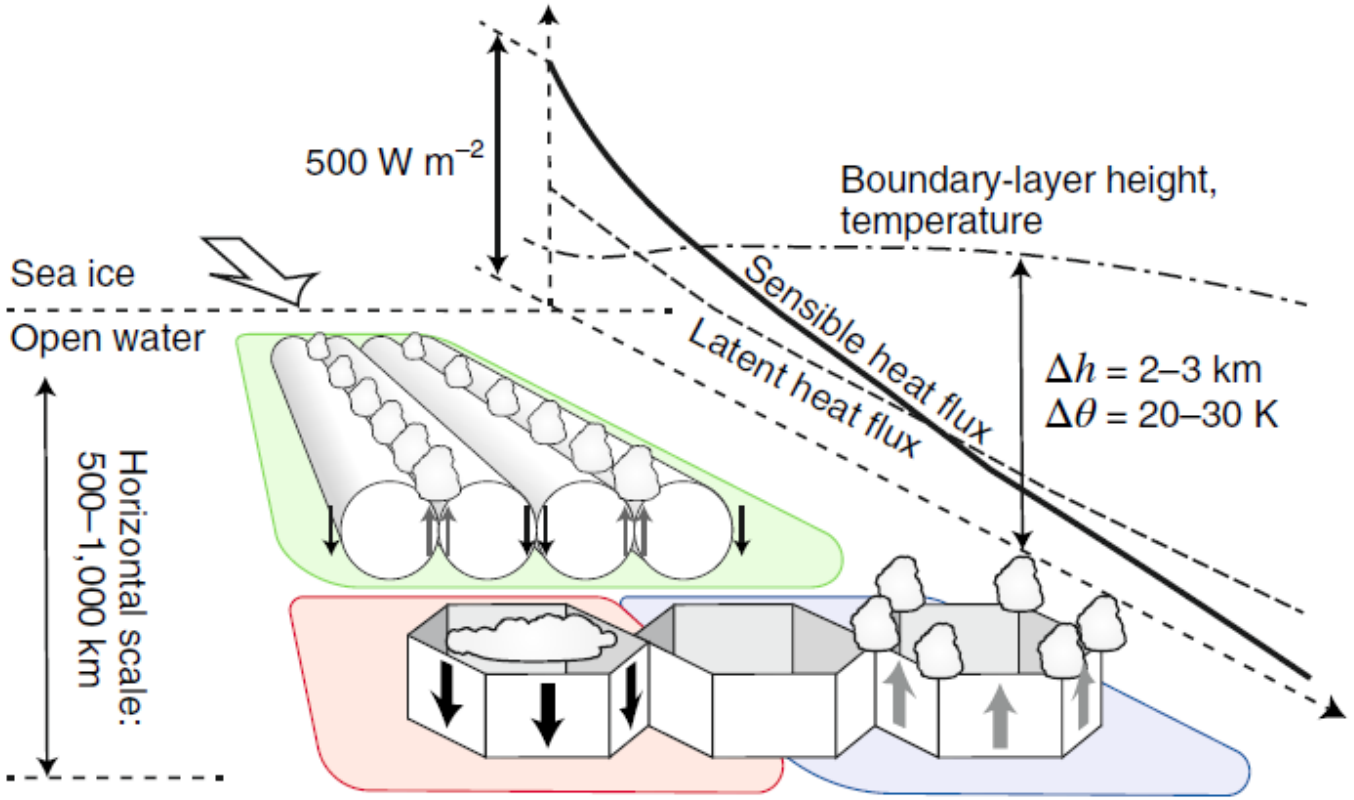
Stockholm University



ERA-Interim Climatology (15 March – 15 April, 1979-2017)

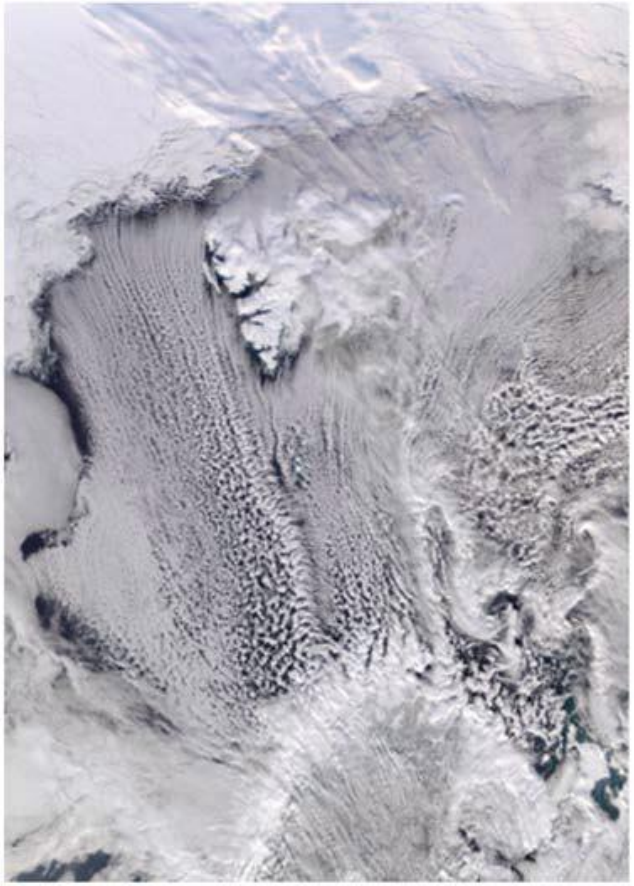
Courtesy Sonja Murto, Stockholm University

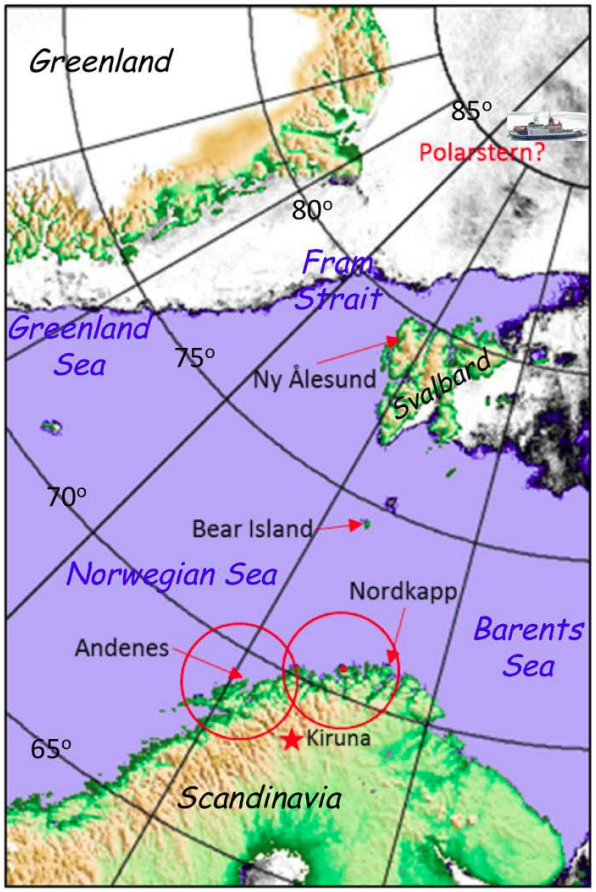
Airmass transformation
Cold-air advection



Pithan, F., G. Svensson, R. Caballero, D. Chechin, T.W. Cronin, A.M.L. Ekman, R. Neggers, M.D. Shupe, A. Solomon, M. Tjernström, and M. Wendisch, 2018: Role of air-mass transformations in exchange between the Arctic and mid-latitudes, Nature Geoscience, [doi:10.1038/s41561-018-0234-1](doi:10.1038/s41561-018-0234-1)

COMBLE (Cold-air Outbreaks in the Marine Boundary Layer)
ARM Mobile Facility at Northern Norway and Bear Island: 1 Jan – 31 May





Summary

Stockholm University

YOPP consolidation phase includes a SOP3-NH focusing on processes important for Arctic airmass transformations

MOSAiC is part of YOPPsiteMIP, aim is to provide observational data for modelers in easy-to-use format – same for all locations

MOSAiC data will be on GTS, aim to add ocean and sea-ice observations

Suggested period, 16 March – 7 April, 2020 for additional radiosonds at existing stations during aircraft campaign when dropsonds also will be employed

Unfortunately, most other planned aircraft campaigns are postponed to 2021 and not yet confirmed…